

**ROCKY FLATS PLANT
EMD OPERATING
PROCEDURES MANUAL**

**Manual No.: 5-21000-OPS-SW
Procedure No : Table of Contents, Rev 4
Page: 1 of 2
Effective Date 05/12/92
Organization: Environmental Management**

THIS IS ONE VOLUME OF A SIX VOLUME SET WHICH INCLUDES:

**VOLUME I: FIELD OPERATIONS (FO)
VOLUME II: GROUNDWATER (GW)
VOLUME III GEOTECHNICAL (GT)
VOLUME IV: SURFACE WATER (SW)
VOLUME V: ECOLOGY (EE)
VOLUME VI: AIR (AP)**

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ADMIN RECORD

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REVIEWED FOR CLASSIFICATION/UCNI

By [Signature]
Date May 18, 1992
[Signature]

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TITLE
SURFACE WATER DATA
COLLECTION ACTIVITIES

Approved By

[Signature]
(Name of Approver)

MAY 12, 1992
(Date)

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By *[Signature]*
Date *March 9, 1992*

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used at the Rocky Flats Plant (RFP) in the performance of field activities at surface water collection sites. This SOP describes initial site evaluation procedures and outlines an order of data collection activities to be performed at each site by a two or three member field crew. Details are provided in this document so that all sampling personnel following these procedures will deliver samples to the laboratory and will perform discharge and field parameter measurements in a consistent manner.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

The project manager or task leader is responsible for assigning project staff to complete surface water data collection activities at RFP property. The task leader is also responsible for ensuring that this and other appropriate procedures are followed by project personnel.

Personnel performing surface water sampling activities will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure.

General Environmental Protection Program DOE Order 5400.1 November 1988

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Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final EPA/540/g-89/004, October 1988

RCRA Facility Investigation Guidance U S Environmental Protection Agency, Interim Final May 1989

Test Methods for Evaluating Solid Waste. Physical/Chemical Methods, SW-846 EPA September 1986

NPDES Compliance Sampling Inspection Manual U S Environmental Protection Agency, MCD-51 1979

NPDES/FFCA Operations Sampling Plan Environmental Management Surface Water Division, Rocky Flats (In Progress)

4.2 INTERNAL REFERENCES

Related SOP's cross-referenced by this SOP are as follows

- SOP FO.3, General Equipment Decontamination
- SOP FO 6, Handling of Personal Protective Equipment
- SOP FO 7, Handling of Decontamination Water & Wash Water
- SOP FO 10, Receiving, Labeling, and Handling Environmental Materials Containers
- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP FO 19, Base Laboratory Work
- SOP SW 1, Surface Water Collection Activities

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- SOP SW.2, Field Measurement of Surface Water Parameters
- SOP SW.3, Surface Water Sampling
- SOP SW 4, Discharge Measurements

5.0 METHODS

5.1 PREPARATIONS FOR FIELD ACTIVITIES

To prepare for the daily field data collection activities, SOP FO 19, Base Laboratory Work, will be followed. In addition, the field teams will verify that items required in the field equipment checklist (Form SW 1B) are in the field vehicle and are in proper working order before leaving for the field each day.

5.2 SITE EVALUATION

Upon arrival at the field data collection site, the field crew will park the field vehicle on the most level ground available, as close to the surface water site as is practical. The crew will review the sample site field folder to locate the sampling point and to become familiar with historical conditions at the site.

The crew will select an area to perform decontamination procedures. The decontamination facility must be located between the sampling site and the field vehicle. Decontamination equipment will be placed on plastic sheeting a reasonable distance away from both the sampling site and the field vehicle, and will be arranged for efficient use.

The crew will carry the following to the data collection site: (1) instruments for measuring in-stream water quality parameters and temperature, (2) equipment for measuring discharge appropriate to the flow regime, and (3) water sampling equipment and containers. However, typically, the crew will be able to work directly from the field vehicle. In this case, the crew will

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proceed to the stream or data collection point.

The sampling team will perform field parameter measurements as described in SOP SW.2, Field Measurement of Surface Water Field Parameters. The team will collect representative water quality samples as outlined in SOP SW.3, Surface Water Sampling, and will perform discharge measurements as described in SOP SW.4, Discharge Measurement. Water quality samples will always be obtained before discharge measurement. The proper sequence for these procedures is addressed in Section 5.3.

5.3 DATA COLLECTION

A suggested sequence for data collection and site activities is as follows:

- Dress in appropriate personal protective equipment (PPE)
- Set up decontamination line
- In accordance with the field folder, SOP SW.3, Surface Water Sampling, and SOP SW.4, Discharge Measurement, a technician will select and assemble water sampling and discharge measuring equipment. The equipment will be arranged conveniently on plastic sheeting.
- A technician will record site I.D., date, names of party members, weather conditions, and air temperature.
- A technician will observe and record site-specific conditions which impact selection of flow measurement or water sampling techniques.

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- A technician will evaluate the site and determine the point at which sampling and discharge measurements will be accomplished, as per guidelines in SOP SW.3, Surface Water Sampling and SOP SW.4, Discharge Measurement.
- A technician will measure and record the water temperature in the field logbook, and will set up the dissolved oxygen (D O) meter for in-situ measurement. The D O probe will be calibrated, as described in SOP SW.2, Field Measurement of Surface Water Field Parameters The D.O will then be measured and recorded in accordance with SOP SW.2
- A technician will assemble, check and/or calibrate the pH meter and conductivity meter as described in SOP SW.2, Field Measurement of Surface Water Field Parameters A technician will then measure pH, specific conductance, alkalinity, and other field parameters, and filter samples as required in SOP SW.2 and SOP SW.3 Field parameter measurements and sampling times will be recorded on the field form
- If the water is to be sampled for VOCs, Cyanide, or BNA analysis, a technician will collect a representative sample from the stream to be analyzed for Total Residual Chlorine This is needed to determine preservation requirements for those samples Total Residual Chlorine measurements will be made in accordance with SOP SW.2, Field Measurements of Surface Water Field Parameters.
- A technician will then employ the appropriate method to collect representative water quality samples from the stream in accordance with SOP SW.3, Surface Water Sampling, and will perform the remaining field parameter measurements A technician will record the sample time, to the nearest five minutes, and carry the water samples to the decontamination area

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- A technician will decontaminate and package the samples, according to SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.
- A technician will perform a premeasurement spin test of the current meter if it is to be used for discharge measurement, and will record the result of the spin test. This test will be performed in a place sheltered from the wind.
- A technician will measure discharge by using the method appropriate to the flow regime, as described in SOP SW 4, Discharge Measurement
- A technician will perform a post-measurement spin test of the current meter if it has been used for discharge measurement, and will record the result on the Surface Water Data Collection Field Notes
- A technician will disassemble, decontaminate, and store the data collection instruments. Decontamination methods are detailed in SOP FO.3, General Equipment Decontamination
- Environmental liquids, including decontamination water, residual samples, and wash water will be handled as described in SOP FO 7, Handling of Decontamination Water and Wash Water
- Environmental materials will be handled in accordance with SOP FO 10, Receiving, Labeling, and Handling Environmental Materials Containers
- Both technicians will survey the area to verify that all equipment has been returned to the vehicle

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- The technicians will perform personal decontamination in accordance with SOP FO 6, Handling of Personal Protective Equipment, before entering the field vehicle or proceeding to the next data collection site or the base laboratory operation facility

The foregoing sequence of data collection and site activities may vary with site conditions. For example, discharge may not be measured if there is no flow. However, field activities will be generally guided by the list, and a technician initiating a specific task will carry the task to completion.

6.0 DOCUMENTATION

All field activities will be recorded in field logbooks or on field forms. The Surface Water Data Collection Form (Form SW 1A) is used to record surface water sample collection data. Descriptions of problems encountered and deviations from the SOP will also be recorded.

The Surface Water Data Collection Form is used to record data collected at each site. The information on the form should be initialed next to each entry as it is made. All data obtained in surface water data collection activities will be recorded in the surface water field note. The surface water data collection form also includes sections for sampling conditions, methods, and weather conditions. Field note entries will include, at a minimum, the following information:

- Date and time of each entry or activity
- Names of field personnel
- Names of all visitors to the site during field activities
- Location of field activities
- Description of sampling conditions, location, method, sampler types, materials, and weather

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- **Field parameter measurements**
- **Discharge measurements and calculations**
- **List of analytes and preservatives**
- **Comments and observations**

SURFACE WATER DATA COLLECTION FIELD NOTES

SAMPLE ID. _____ SITE ID. _____ LOCATION: _____

COLLECTION DATE: _____ QUARTER: 1 2 3 4 DRY: Y / N

COLLECTION TIME: _____ PURPOSE: _____

SAMPLE TYPE Grab Composite Depth-Integrated EWI-Composite Other _____

COMPOSITE DESCRIPTION: _____

QC TYPE REAL MS MSD LR DUP RNS QC PARTNER: _____

SAMPLES COLLECTED BY IMMERSION: _____

SAMPLES COLLECTED BY DIPPER: _____

SAMPLER TYPE Bucket Beaker/Dipper Other _____

TEAM LEADER _____ TECH _____ TECH _____ TECH _____

VOLUME COLLECTED. _____ UNITS _____

COMMENTS DISSOLVED METALS FILTERED OTHER: _____

Sample Location Description Pool Pond Puddle Stream Seep Ditch Other _____

Water Is Rising Falling Steady Insuff Water Dry Ice Coverage % _____ Other _____

Sampled from: Shore Waded Boat Bridge Other _____

Collection Points LB/RB _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, LB/RB

Sampler Composition Teflon Glass Stainless Steel Other _____

Weather

Clear Calm Hot Sunny P/C Lt Breeze Warm Fog Cloudy Windy Cool Rain
Gusty Cold Sleet V Cold Snow Other _____

SITE VISITOR _____ COMPANY _____

SITE VISITOR _____ COMPANY _____

SITE VISITOR _____ COMPANY _____

Sampler _____ Parameters _____

FIELD CALIBRATION								
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
pH			UNITS			—		
SC			mS/CM					
DO			MG/L					

Prepared by _____ Signature _____

SURFACE WATER DATA COLLECTION FIELD NOTES

DEPTH _____		FIELD MEASUREMENTS						
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
T air			°C		—	—		
T H ₂ O			°C		—	—		
DO			MG/L		—			
pH			UNITS		—			
CL ₂			MG/L	—	DPD	—		
ALKA			MG/L		1.6/ 16 N H ₂ SO ₄ /50ml 100ml	DIGITAL COUNTS 8.3 4.5		
SC			ms/CM					
SILICA								

DISCHARGE MEASUREMENT NOTES

Party _____ Comp By _____ Checked By _____
 Width _____ Area _____ Gage Height _____
 Method _____ Type of Meter _____ Spin Before _____ After _____
 Comments/observations _____

Cross Section _____
Flow _____
Other _____

[illegible]

Total Discharge

Site ID _____ Date _____ Signature _____

FIELD EQUIPMENT CHECKLIST

1 SW Equipment

Conductivity Meter

pH meter and standards

Dissolved Oxygen (D O) meter

Alkalinity equipment titrator, stir bars, stirrer, acid cartridges (16 and

1 6N H₂SO₄)

Sample bottles (plus extras)

Thermometers

Samplers for all sampling conditions (including extension rods)

Sample Coolers

Sample Containers with appropriate preservatives

Blue ice

Gloves

Churn splitter (if required)

Peristaltic pump

pH paper

Lab glassware

Filters (0 45 µm in-line filters)

Non-breakable volumetric flasks with lids 50 ml and 100 ml

Plastic storage bags for samples

Sample labels

Chain-of-custody forms

Marker Pens

2 Personal Equipment

Communication radio

PPE, as discussed in the Health and Safety Plan

Wrist or pocket watch

Rain gear

Duct tape

Pocket knife

First aid kit

Water cooler, filled with drinking water, and paper cups

3. Stream-Gaging Equipment

Clipboard with string to attach to hydrographer (if desired)

Velocity chart

Type AA current meters with spare parts (for high flow conditions only)

1 pygmy meter, with very small screwdriver

1 wading rod (complete)

1 head set (complete for wading measurements) and/or velocity meter

1 pair waders

1 stop watch

2 life jackets (for pond sampling in a boat)

Calibrated volumetric containers

Steel tapes and/or taglines, as required

Axe

Shovel

Meter Oil

4 Decontamination Equipment

Nonphosphate detergent

Distilled water, and, if desired, potable water

Buckets with lids, or other containers for environmental water

Brushes

Plastic Sheeting

5 Hand Tools and Supplies

Tool box

1 claw hammer

2 to 4 screwdrivers (small to large)

1 ordinary pliers

1 roll electrician's tape

6 Forms and Supplies

1 briefcase equipped with the following

Applicable SOPs, HSP, FSP, and other required documentation

All necessary forms

Logbooks

Field folders for site to be evaluated

7 Automotive Equipment

Jack

Chains

Spare tire

Automobile accident forms

Credit cards

Tow rope or chain

Jumper cables

This is a
CONTROLLED DOCUMENT

EG&G - ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT

This is a RED Stamp

FIELD MEASUREMENTS OF SURFACE WATER FIELD PARAMETERS

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TITLE
FIELD MEASUREMENT OF SURFACE
WATER FIELD PARAMETERS

Approved By:

J. E. M. M. M.
(Name of Approver)

MAY 1 1992
(Date)

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used at the Rocky Flats Plant (RFP) to obtain measurements of surface water parameters in the field. These parameters are temperature, dissolved oxygen, pH, alkalinity, specific conductance, total residual chlorine, free chlorine, turbidity, hardness, and nitrates. This SOP describes field measurement procedures, personnel responsibilities and qualifications, and quality assurance/quality control (QA/QC).

3.0 RESPONSIBILITIES AND QUALIFICATIONS

Personnel measuring surface water field parameters will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

A Compendium of Superfund Field Operations Methods EPA/540/P-87/001 U.S. Environmental Protection Agency. Washington, D.C. 1987.

Data Quality Objectives for Remedial Activities Development Process EPA/540/G-87/003 U.S. Environmental Protection Agency. Washington, D.C. 1987.

L.R. Kister and W.B. Garrett Field Guidelines for Collection, Treatment and Analysis of Water Samples, Arizona District U.S. Geological Survey, Water Resources Division. November 1984.

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HACH DR/2000 Spectrophotometer Handbook, 1988

HACH ONE Electrode System Manual. 9-8-89-SED HACH Company Loveland, CO 1989

HACH Quick Reference Card K81-2ED HACH Company Loveland, CO.

Instruction Manual Model 44600 Conductivity/TDS meter 5-23-89-6ED HACH Company
Loveland, CO 1989

Methods for Chemical Analysis for Water and Waste EPA-600/4-79-020 March 1983 Methods
150.1 and 330.5

Standard Methods for the Examination of Water and Wastewater 16th Edition Method 212. 1985

The Environmental Survey Manual DOE/EH-0053 Appendix E, "Field Protocols and Guidance"
U.S. Department of Energy Washington, D.C. August 1987

NPDES/FFCA Operations Sampling Plan. Environmental Management Surface Water Division,
Rocky Flats (In Progress)

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows

- SOP FO.3, General Equipment Decontamination
- SOP FO 7, Handling of Decontamination Water and Wash Water

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- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP SW.3, Surface Water Sampling

5.0 FIELD MEASUREMENT PROCEDURES

Calibration procedures for the equipment described in this section are found in Appendixes SW.2A and SW.2B

5.1 TEMPERATURE

Temperature measurements will be made with a high quality mercury-filled thermometer or thermistor having an analog or digital readout device. This thermometer is to have been standardized by comparison with a thermometer calibrated against a National Institute of Standards and Technology (NIST) calibrated thermometer. All temperature-measuring devices will be scaled to indicate degrees Celsius and marked as appropriate to meet data quality objectives. Glass thermometers will be transported in a protective case to prevent breakage. Thermometers will be Teflon® coated safety type, 305 mm in length, and scaled from -20°C to +110°C in 1° increments (VWR CAT No. 61017-823 or equivalent). Field thermometers will also be enclosed in an armored casing to prevent breakage (VWR CAT No. 61017-562 or equivalent).

Temperature measurements made for the purpose of providing adjustment factors for other field parameters will be conducted simultaneously with those related measurements. Volumes and methods of collection will be determined by the procedural requirements of the primary field measurement taken. Thermometer or thermistors used in the field will be standardized at least monthly against an NIST traceable thermometer.

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- Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between sites, when performing field temperature measurements.
- Only mercury-filled thermometers or thermistors that are in calibration will be used
- Inspect the thermometer before each field trip to ensure that there are neither cracks in the glass nor air spaces or bubbles in the mercury
- If a thermometer should be broken in the field, the location will be noted in the logbook and the site supervisor and health and safety officer will be notified immediately
- Allow the thermometer or thermistor enough time to equilibrate to outside temperature when removed from a field vehicle
- Insert the thermometer or thermistor into the stream. Swirl the thermometer or thermistor if the medium is calm and take the temperature reading when the mercury column or digital readout stabilizes
- Record the temperature reading in the field logbook to the nearest $\pm 0.5^{\circ}\text{C}$
- Decontaminate the thermometer or thermistor in accordance with SOP FO.3, General Equipment Decontamination.

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- Liquids from decontamination operations will be handled in accordance with SOP No FO 7, Handling of Decontamination Water and Wash Water.

5.2 TOTAL RESIDUAL CHLORINE (TRC)

Collect a representative 500-ml grab sample from the collection point into a sample bottle in accordance with SOP SW.3, Surface Water Sampling. Pour off approximately 50 ml to be used to determine TRC concentration. Cap remaining sample and retain in a cool location for later use in determining pH, alkalinity, and other field parameters.

Samples for analytes that are susceptible to changes in chemical composition due to high levels of TRC must be specially preserved when this condition exists. Before collection of samples at a sampling site, the TRC concentration must be measured. At sites where the concentration is measured to be ≥ 0.20 mg/l, volatile organic compounds (VOCs), cyanide and BNA samples will be preserved in accordance with SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. In the event that insufficient water is available to collect the entire sample suite, TRC should still be measured before sampling to determine sample preservation requirements. It is not necessary to measure TRC first if VOCs, cyanide or BNA are not being collected. If the TRC concentration exceeds 0.50 mg/l for any NPDES discharge points, contact the site supervisor immediately. The site supervisor will then contact the Environmental Management Surface Water Division at Rocky Flats.

TRC measurements at RFP will be conducted with a HACH DR/2000 spectrophotometer or equivalent. See equipment manufacturer's instructions for equipment-specific procedures. Take care to ensure that ampul tips are broken under water.

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5.3 TOTAL FREE CHLORINE (TFC)

The procedure for the measurement of this field parameter is included here to provide a reference for programs which may include this parameter (i.e, NPDES sampling).

TFC measurements at RFP shall be conducted with a HACH DR/2000 Spectrophotometer or equivalent See equipment manufacturer's instructions for equipment-specific procedures.

5.4 DISSOLVED OXYGEN (D.O.)

5.4.1 YSI Model 57 D.O. Meter

Procedures for the YSI Model 57 D O meter will be as follows.

- Inspect the membrane before each field use for air bubbles, oily film, and/or holes. If the membrane is defective, it must be replaced and soaked before recalibration in accordance with manufacturer's literature.
- Calibrate the meter at each site prior to use. Instructions for the calibration procedure are included in Appendix SW.2B.
- Perform an in-situ measurement by placing the D O electrode into the medium to be measured and reading the D O meter to the nearest 0.1 mg/l. Record the D O concentration and the range setting of the D.O meter.
- If the D O. meter is equipped with an operational thermometer, read the water temperature at the time the D O is measured. If the meter does not provide a

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temperature reading, measure and record the water temperature as described in Subsection 5.1

- Consult Table 1 of Appendix SW.2B for the solubility of oxygen at the recorded temperature. If the measured D.O. value exceeds the solubility of oxygen at the given temperature, the D.O. value should be verified in the field by another method. The HACH DR/2000 can be used for this purpose. Consult the HACH manual for detailed instructions. Record the second D.O. value in the comment section of the field data collection form.
- Protect the YSI D.O. probe when not in use to prevent the membrane from drying out or freezing.
- Sampling tools, instruments, and equipment will be protected from sources of contamination before use and decontaminated after use as specified in SOP FO.3, General Equipment Decontamination.
- Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between sites, when performing field D.O. measurements.
- Manufacturer's operating manuals and calibration procedures will be followed.

5.4.2 Hach DR/2000 Spectrophotometer

Dissolved oxygen may be measured using the Hach DR/2000 Spectrophotometer. See the manufacturer's instructions for specific procedures.

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5.5 pH

Measurements of pH are affected by changes in temperature. Mechanical and chemical changes in pH measuring electrodes due to temperature change can cause erroneous pH readings. The HACH One pH meter is a temperature compensating device. This or similar devices should be used for pH measurement to avoid introducing error.

The pH of water is also affected by exposure to the atmosphere. Carbon dioxide can escape from an exposed grab sample, thus altering pH in the sample. As described in Subsection 5.2, Total Residual Chlorine, the grab sample used for field parameter measurements should be capped and retained in a cool location to avoid pH changes.

pH is a measure of the activity of hydrogen ions in solution. Water samples will have varying ionic species and ionic strength, both of which affect the hydrogen ion activity. Accurate determination of pH is difficult in high ionic strength solutions due to this phenomenon. Proper electrode conditioning is necessary when measuring the pH of high ionic strength solutions.

Meters will be calibrated daily in the laboratory or field trailer prior to field use. Meters will also be checked against a pH 7.0 buffer in the field prior to use at each sampling site. Buffer solutions will be changed periodically for calibration checks.

If sample pH is less than 6 or greater than 9 pH units at NPDES discharge points, report results immediately to site supervisor, who will then report to the Environmental Management Surface Water Division at Rocky Flats.

Alkalinity measurements will accompany and immediately follow pH measurements detailed in this procedure and are to be considered an extension of the pH measuring process, not as an independent operation.

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Measurements in the field will be performed in the following manner (EPA method 150.1)

- Before each field activity, check the meter for cracked or fouled electrodes and battery condition in accordance with manufacturer's recommendations.
- Check the instrument prior to use at the site by observing the reading obtained with a pH 7.0 buffer solution. The probe shall be free of contamination and dry before insertion into the buffer to limit cross-contamination and/or dilution of the solution. Recalibrate the instrument if pH is more than .2 pH units greater or less than buffer pH for the given temperature.
- Thoroughly rinse the electrode and temperature probe with distilled water and remove excess water.

Note When measuring samples of high ionic strength, condition the electrode after cleaning by dipping it into a portion of the sample water to be measured. After one minute, remove the electrode, blot dry, and then immerse in a fresh portion of the sample.

Sulfuric acid reagent (0.1600N or 1.600N) will be used in the alkalinity titrations. The 0.1600N H_2SO_4 reagent is preferable for alkalinities less than 100 mg/L. Above 100 mg/L, the 1.600N H_2SO_4 is preferable due to time constraints, but this higher concentration of acid is only to be used after previously recorded titrations indicate alkalinity greater than 100 mg/L.

- If the 0.1600N reagent has been selected, measure 50 ml of the 500-ml sample in a volumetric flask, then pour it into a 100-ml beaker containing a magnetic stir bar. This sample must be exactly 50 ml.

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- If the 1 600N reagent has been selected, place 50 ml of the grab sample into a 100-ml beaker as above, or place 100 ml into a 250-ml beaker containing a magnetic stir bar. Leave the magnetic stirring device off until the alkalinity titration procedure has begun. The sample, whether 50 ml or 100 ml, is measured with a volumetric flask and must be exact.
- Place the electrode and the temperature probe into a beaker containing 100 ml of the 500-ml sample and swirl the electrode at a constant rate until the meter reading stabilizes. The stirring rate should be maintained so as to minimize the surface disturbance of the sample.
- Note and record the indicated temperature of the sample to the nearest $\pm 0.1^\circ \text{C}$, and the pH to the nearest ± 0.1 pH unit.
- Rinse the electrode and temperature probe thoroughly with distilled water and store in accordance with manufacturer's recommendations.
- Sampling tools, instruments, and equipment will be protected from sources of contamination before use and decontaminated after use as specified in SOP FO.3, General Equipment Decontamination.
- Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between sites, when performing field pH measurements.

5.6 ALKALINITY

Alkalinity measurements will accompany and immediately follow pH measurements detailed in Subsection 5.5 of this procedure. Titration with an appropriate acid reagent will be used to measure

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alkalinity Alkalinity measurements at the RFP will be conducted with a HACH digital titrator or equivalent. Follow the general procedures described below and see equipment manufacturer's instructions for detailed equipment-specific titration procedures.

- Sampling personnel will wear chemical-resistant gloves, which will be disposed of between sites, when performing alkalinity measurements.
- Determine the appropriate end-point pH according to alkalinity species in question (4.5 or 4.5 and 8.3 if initial pH > 8.3).
- Prepare sample and titration assembly
- Titrate to endpoint pH by making smaller additions of acid as the endpoint is approached
- Use appropriate conversions based on reagent normality and sample size to calculate alkalinity

5.7 SPECIFIC CONDUCTANCE (SC)

Conductance is a measure of the ability of an aqueous solution to conduct electrical current and is expressed in reciprocal ohms (mhos). The International System of Units uses the siemen(s) to represent mhos. The siemen will be the unit used in this SOP.

The physical dimensions of a conductance measuring probe define the cell constant for the probe. When this constant is known and applied, conductance is converted to units of specific conductance (SC) (aka, conductivity). Most waters have a SC much less than 1 siemen, therefore, data will be reported in millisiemens (mS)/cm or microsiemens (μ S)/cm.

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The Hach 44600 Conductivity/TDS meter has been pre-set in the factory with a cell constant of 1.0. The cell constant is determined by using a potassium chloride (KCl) standard solution. The temperature coefficient (used in cell constant determination) of most waters is only approximately the same as that of the KCl solution. The greater the temperature difference between the KCl standard and the sample, the greater the uncertainty in the measurement of SC. For greatest measurement accuracy, the KCl solution and the sample should both be 25 °C.

SC increases with temperature. The meter is temperature compensating, correcting readings to the standard temperature 25°C, over the temperature range 0-100°C. Thus, no error should be introduced in conductivity measurements due to temperature.

The HACH 44600 Conductivity/TDS meter will be standardized each day before field activities against a 1000 $\mu\text{S}/\text{cm}$ solution and a 10,000 $\mu\text{S}/\text{cm}$ solution. These standards define the limits, between which conductivity readings are reliable. Solutions of particularly high ionic strength (with conductivity > 10,000 $\mu\text{S}/\text{cm}$) should be diluted to 50 percent strength until readings fall within the prescribed limits.

The following method will be used to measure SC in the field (EPA method 330.5)

- Before each field activity, check the meter for damage to the probe and for weak batteries in accordance with manufacturer's recommendations.
- Calibrate the meter in the field prior to use at each site. Instructions for the calibration procedure are included in Appendix SW.2A.
- Thoroughly rinse the probe in distilled water and remove excess water by gently shaking and drying with clean paper towel before immersion in the sample.

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- A 250-ml portion of the 500-ml grab sample described in Subsection 5.2, Total Residual Chlorine, will be measured for SC
- Immerse the probe into the sample to a depth of at least 1 inch below the surface of the sample. Agitate the probe gently to dislodge any trapped air bubbles and allow the meter reading to stabilize
- Record the temperature and the temperature-compensated reading in the daily field logbook
- Rinse the probe thoroughly with distilled water after use and dry with a clean paper towel
- Sampling tools, instruments, and equipment will be protected from sources of contamination before use and decontaminated after use as specified in SOP FO.3, General Equipment Decontamination
- Sampling personnel shall wear chemical-resistant gloves, which will be disposed of between sites, when performing field conductivity measurements.

5.8 SILICA (SiO_2)

In the event that SiO_2 measurements are needed, the Silicomolybdate method is used to measure silica in the range of 0 - 100 mg/l, and the Heteropoly Blue method measures silica in the 0 - 16 mg/l range. Silica measurements at RFP will be conducted with a HACH DR/2000 spectrophotometer or equivalent. See equipment manufacturer's instructions for equipment-specific procedures.

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5.9 TURBIDITY

This procedure describes the measurement of turbidity using the HACH DR/2000 Spectrophotometer absorptometric method. The turbidity test measures an optical property of the water sample which results from the scattering and absorbing of light by the particulate matter present. The amount of turbidity registered is dependent on such variables as the size, shape, and refractive properties of the particles. This procedure is calibrated using formazin turbidity standards, and the readings are in terms of formazin turbidity units (FTU).

- Sampling personnel will wear chemical-resistant gloves, which will be disposed between sites, when performing turbidity measurements.
- Enter the stored program number for turbidity; press "750 Read/Enter." The display will show "Dial nm to 450."
- Rotate the wave length dial until the small display shows "450 nm."
- Press "Read/Enter." The display will show "FTU Turbidity."
- Pour 25 ml of deionized water (blank) into a sample cell.
- Place the blank into the cell holder and close the light shield.
- Press "zero" and the display will show "wait" and then "0 FTU Turbidity."
- Agitate the sample designated for turbidity measurement so that all sediments are suspended. Pour 25 ml of the sample into another clean sample cell, place into the cell holder and close the light shield.

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- Press "Read/Enter" and the display will show "wait" and then the result in FTUs will be displayed
- Read value and record in logbook

5.10 HARDNESS

Hardness is defined as a characteristic of water which represents the total concentration of calcium and magnesium ions expressed as their calcium carbonate equivalent (mg/l CaCO_3). Calcium and magnesium ions are the principle causes of water hardness. Although less common in natural waters than calcium and magnesium, other ions (i.e., iron, aluminum, manganese, strontium, zinc and hydrogen) are capable of producing the same hardness effect and will be included in the results.

Ethylenediaminetetraacetic acid and its sodium salts (abbreviated EDTA) form a chelated soluble complex when added to a solution of certain metal cations. If a small amount of a dye such as Erichrome Black T or Calmagite is added to an aqueous solution containing calcium and magnesium ions at a pH of 10.0 ± 0.1 , the solution becomes wine red. If EDTA is added as a titrant, the calcium and magnesium will be complexed, and when all of the magnesium and calcium has been complexed the solution turns from wine red to blue, marking the end point of the titration. Magnesium ions must be present to yield a satisfactory end point. To insure this, a small amount of complexometrically neutral magnesium salt of EDTA (Mg-CDTA) is added to the buffer (HACH Buffer Solution, Hardness 1); this automatically introduces sufficient magnesium.

This procedure describes the measurement of hardness using the digital titration method for an expected concentration range of 0-250 mg/l total hardness.

- Sampling personnel shall wear chemical-resistant gloves, which will be disposed between sites, when performing hardness measurements.

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- Attach a clean 90° delivery tube to a 0.800M EDTA Titration Cartridge. Twist the cartridge onto the titrator body. Hold the Digital Titrator with the tip pointing up. Flush out the air in the delivery tube by turning the delivery knob until a few drops of titrant are ejected from the tube and no visible air remains in the cartridge. Reset the counter to zero and wipe the tip. Attach the digital titrator to the laboratory stand.
- Using a graduated cylinder, add 100 ml of sample into a 125-ml erlenmeyer flask containing a magnetic stir bar. Turn on the magnetic stirrer and maintain a rate so as to minimize the surface disturbance of the sample.
- Add 2 ml of Hardness 1 Buffer Solution and swirl to mix. The addition of this buffer will bring the pH of the solution to 10.0 ± 0.1 .
- Add the contents of one ManVer 2 Hardness Indicator Powder Pillow and swirl to mix. The color of the solution should turn to wine red.
- Place the delivery tube tip into the solution and titrate the sample until the color changes from red to blue. Titrate slowly toward the end point as it takes time for the reaction and color change to take place, especially in cold water. A limit of 5 minutes is set for the duration of the titration to minimize the tendency toward CaCO_3 precipitation.
- Read the concentration of total hardness (as mg/l CaCO_3) from the digital counter and record the results.

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5.11 NITRATES

Nitrate represents the most completely oxidized state of nitrogen commonly found in water. Nitrate forming bacteria convert nitrites (NO_2) into nitrates (NO_3) under aerobic conditions and lightning converts large amounts of atmospheric nitrogen (N_2) directly to nitrates. High levels of nitrate in water indicates biological wastes in the final stages of stabilization or run-off from heavily fertilized fields. Nitrate rich effluents discharged into receiving waters can degrade water quality by encouraging excessive growth of algae.

This procedure describes the measurement of Nitrate using the HACH DR/2000 Spectrophotometer absorption method

- Sampling personnel shall wear chemical-resistant gloves, which will be disposed between sites, when performing Nitrate measurements
- Enter the stored program number for Nitrate, High Range, press "360 Read/Enter". The display will show "Dial nm to 500"
- Rotate the wave length dial until the small display shows "500 nm"
- Press "Read/Enter". The display will show "mg/l N NO_3 - H AV"
- Collect at least 40 ml of sample in a 50 ml beaker. Fill the rubber ampul cap with sample. Fill a NitraVer 5 Nitrate AccuVac Ampul with sample by immersing it in the beaker and breaking the tip along the side of the beaker. Keep the tip immersed while the ampul fills completely. Cover the ampul with the cap.

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- Press "Shift Timer". A one minute mixing period will begin. Invert the ampul repeatedly until the timer beeps. Wipe off any liquid or fingerprints
- When the timer beeps, press "Shift Timer". A five minute reaction time will begin. An amber color will develop if nitrate-nitrogen is present
- Fill a zeroing vial with at least 10 ml of sample (the blank)
- When the timer beeps, the display will show "mg/l N NO₃ - H AV". Place the blank into the cell holder and close the light shield
- Press "Zero" and the display will show "Wait" and then "0.0 mg/l N NO₃ - H AV"
- Place the AccuVac ampul into the cell holder and close the light shield
- Press "Read/Enter" and the display will show "Wait", then the nitrate result in mg/l nitrate-nitrogen (NO₃-N) will be displayed. Record the value

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance (QA) and quality control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP. Equipment inspection and calibration QC requirements for each field parameter measurement procedure are described in Section 5.0 of this SOP.

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7.0 DOCUMENTATION

Information required by this SOP will be documented on the Surface Water Data Collection Field Notes Form (Form SW 1A) or the NPDES daily log sheets. NPDES log sheets are described in the NPDES/FFCA Operations Sampling Plan. Use of these forms is described in SOP SW 1, Surface Water Data Collection Activities. Data required by this SOP include calibration records and measurements of temperature, D O, pH, alkalinity, SC, TRC, TFC, turbidity, hardness and nitrates.

APPENDIX SW.2A

CALIBRATION AND STANDARDIZATION PROCEDURES

APPENDIX SW.2A - CALIBRATION AND STANDARDIZATION PROCEDURES

These instructions are for the use of persons who will use these field measurements on a daily basis and are not intended to either supersede or supplement required periodic laboratory calibration or manufacturer's guidance for initiation of new equipment. In all cases, care will be taken to ensure that reagents and standards are employed that have not exceeded their expiration dates

Standardization is the process of determining the deviation between the known value of a standard and the value for that standard measured by an instrument. Calibration is the process of adjusting an instrument by that deviation such that known and measured values for a standard are equivalent

A.1 THERMOMETER AND THERMISTOR STANDARDIZATION

Measured values of specific conductance, pH, and D O are all temperature-dependent and the instruments used to measure these parameters also measure and/or compensate for temperature effects. Therefore, accuracy of the temperature measurements obtained with these instruments, as well as any thermometers utilized to measure temperature, must be determined and a record maintained

Laboratory temperature standardization of these instruments will be performed and documented on each instrument monthly. The thermometers and thermistors in each instrument being utilized will be standardized against a thermometer traceable to an NIST calibrated thermometer. Accuracy will be determined throughout the expected working range (generally 0° to 35°C). A three-point standardization within the working range will be used to verify accuracy. The following procedure will be followed

1. Have ready solutions of water in the following temperature ranges. 0 to 10 °C, 15 to 25 °C, 30 to 40 °C
2. Immerse the thermistor or thermometer and the NIST traceable thermometer into the 0-10 degree C solution. After allowing time for readings to stabilize, record the readings of the NIST traceable thermometer and the thermistor or thermometer being standardized
3. Repeat Step 2 using the 30-40 degree C solution. If the temperature value of the thermistor can be adjusted from external control knobs on the instrument, then

the temperature reading of the instrument should be adjusted to the temperature reading of the NIST traceable thermometer and the adjusted value noted in the logbook

- 4 Repeat Step 2 using the 15-25 degree C solution
- 5 Thermometers must read within $\pm 1.0^{\circ}\text{C}$ of the NIST traceable thermometer
Thermometers reading outside this range will not be used for field measurements
Thermistor readings should be within $\pm 2^{\circ}\text{C}$ of the NIST traceable thermometer
Instruments with temperature readings outside this range should be returned to the factory for calibration.

A.2 CALIBRATION OF THE HACH DR/2000 SPECTROPHOTOMETER

The HACH DR/2000 Spectrophotometer, used in the measurement of total residual chlorine and other parameters, is pre-calibrated by the manufacturer. Consult the HACH instrument manual in the event instrument problems occur.

A.3 CALIBRATION OF THE YSI DISSOLVED OXYGEN (D.O.) METER

A.3.1 Calibration in the Base Laboratory

Calibration of the D.O. meter will be performed daily before leaving the base laboratory to check the meter to see if it is in proper working order. This calibration procedure is as follows:

- Prepare an oxygen-saturated calibration solution by agitating 200 ml to one liter of distilled water vigorously for approximately five minutes or agitate in blender for 30 seconds
- Turn the instrument to the "Red Line" setting and adjust the meter needle to correspond to the red line on the instrument
- Turn the instrument to the zero setting and adjust the meter reading to read zero
- Place the probe into the saturated water. Read both the temperature and the D.O. value. Consult the chart in the manufacturer's literature and adjust the

meter scale to the value of saturation at the measured temperature and atmospheric pressure

- If the instrument cannot be calibrated to within ± 10 percent of the standard value, it will require maintenance and recalibration prior to use

A.3.2 Field Calibration

Calibration of the D.O. meter in the field will be performed at each sample site with an Air Calibration Chamber. This device (YSI number 5075, or equivalent) permits calibration of the D.O. meter at the temperature of the water in which the D O is to be measured, thereby minimizing errors due to temperature differences. Steps to follow for calibration are listed in the instruction manual for the YSI Model 57 Dissolved Oxygen Meter. Please refer to page 12 of Appendix SW.2B for calibration procedures. Figure 8, also on page 12, is a useful diagram found in Appendix SW.2B, illustrating the parts of the calibration unit and the D O probe, and is referred to in the calibration text.

A.4 CALIBRATION OF THE HACH ONE pH METER

All pH instruments will receive a daily pre-use calibration and a post-use standardization, both of which will be recorded in field logbooks and base lab notebooks. Before use at each site, the instrument will be checked against the pH 7.0 standard buffer. If the instrument reading is not within ± 0.2 pH units of the standard buffer, the instrument must be recalibrated.

These procedures will require the use of buffer solutions of the type listed below as required by the manufacturer.

- pH 4 buffer - potassium hydrogen phthalate
- pH 7 buffer - potassium phosphate, monobasic, and sodium phosphate, dibasic
- pH 10 buffer - sodium carbonate-bicarbonate

Instructions for pre-use calibration are

- Turn meter on by pressing POWER key. The display will light.
- Depress the pH key.

- Next, press the AUTO/MANUAL key. The AUTO indicator should now be lit, the S1 and pH indicators flashing, and all zeroes appearing on the display
- Remove the cap from the electrode/temperature probe and place the probe into a stirring pH 4 buffer solution and press the potassium chloride dispenser button. Allow approximately 30 seconds after dispensing electrolyte before performing the next operation
- The STANDARD key may now be depressed. Wait until the pH indicator stops flashing. The S2 indicator will begin flashing and the actual pH value will appear on the display (Note The display will indicate the actual pH value at the actual temperature of the buffer solution Consult the variation chart provided with the instrument to determine if the instrument is within appropriate parameters) Record the indicated pH value and temperature, and the adjusted pH value of the buffer at the indicated temperature from the chart in the logbook
- Rinse the electrode/temperature probe with distilled water and blot dry with a clean paper towel
- Place the electrode/temperature probe into a stirring pH 10 buffer solution and again press the dispenser button Wait at least 30 seconds before continuing
- Once again, press the STANDARD key S2 will stop flashing. After the pH indicator stops flashing, the actual pH value at the given temperature will appear on the display Record the indicated pH value and temperature, and the adjusted pH value of the buffer in the logbook
- If, during calibration, the digital readout fails to stabilize in any of the solutions, replacement of the pH electrode and/or the temperature probe may be necessary
- DO NOT PRESS ANY KEY OTHER THAN THE pH KEY at this point or the entire calibration procedure will be nullified.
- Press the pH key

- Rinse the electrode/temperature probe with distilled water and blot dry with a clean paper towel.
- Place the cap on the probe and place the instrument in the case
- This instrument is now ready to perform pH measurements

At the end of the day, a post-use standardization will be performed on the instrument. The pH of the 4, 7, and 10 buffer standards will be measured with the instrument. The values of the standards and measured values will be recorded in the appropriate base lab logbook. Measurement and documentation of the standard buffers will ensure and document that the instrument is still functioning within acceptable limits. Acceptable limits for the instrument will be within ± 0.2 pH units of the standard. If the instrument does not consistently stay within these acceptance limits, then it will become necessary to calibrate the instrument prior to use at every site. The sample manager will consult with the site supervisor and QA officer, and the QA officer will decide if calibration at each site is necessary.

A.5 STANDARDIZATION INSTRUCTIONS FOR THE HACH DIGITAL TITRATOR AND ALKALINITY TITRANT REAGENT USED FOR THE FIELD MEASUREMENT OF ALKALINITY

Calibration of the pH meter will first be accomplished in accordance with Section A.4 of this Appendix. Standardization of the digital titrator with sulfuric acid reagent (0.1600N or 1.600N) will be done monthly or each time a new lot of reagent is received. The standardization procedure will be accomplished as follows:

- Measure 50 ml of a 100-ppm alkalinity standard in a 50 ml volumetric flask.
- Transfer this solution into a clean beaker containing a magnetic stir bar
- Place the beaker on a magnetic stir plate

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- This procedure assumes that the concentration of the purchased alkalinity standard is correct, and therefore the reagent titrant is the solution being standardized

- Load the digital titrator with the appropriate reagent cartridge (0.1600N or 1.600N H_2SO_4)
- Position the pH electrode and digital titrator-dispensing tube into the beaker containing the 50 mls of the 100-ppm alkalinity standard
- Adjust digital count setting knob to ensure that the counts on the digital titrator are set at zero
- Turn on the stir plate and stir the 50 mls of the 100-ppm alkalinity standard at a rate that will keep the solution well mixed but not cause splashing.
- Measure the initial pH of the solution
- Slowly add titrant to the solution. Decrease the rate of addition as the pH approaches 5.0
- Continue to add titrant until the pH lowers to 4.5
- Record the amount of titrant (number of digital counts) required to bring the pH to 4.5
- Multiply the number of digital counts by the appropriate conversion factor (0.2 if the 0.1600N H_2SO_4 was used, and 2.0 if the 1.600N reagent was used)
- Record this result as ppm alkalinity in the base lab notebook
- If the value obtained is not within ± 10 percent of the alkalinity standard, then either the acid reagent concentration is not correct or the digital titrator is not dispensing accurately. The problem must be resolved and corrected. Acceptable titration to within ± 10 percent of the alkalinity standard will be obtained before the titrator and sulfuric acid reagent is to be used.

A.6 CALIBRATION INSTRUCTIONS FOR HACH MODEL 44600 CONDUCTIVITY/TDS METER

The HACH Model 44600 Conductivity/TDS meter will be calibrated daily in the laboratory prior to use in the field. The instrument will not receive a post-standardization since it will be standardized in the field prior to use at each site

Note: A reading within ± 10 percent of the value of the conductivity standard (10,000 or 1,000 $\mu\text{S}/\text{cm}$) and 100 $\mu\text{S}/\text{cm}$ for the zero conductivity standard (distilled water) is within acceptable limits and the meter may be used for field measurements. However, the meter should always be set to read as close as possible to the concentration of the standard. The procedure for calibration of the meter is as follows.

- Press the POWER 1 key and CND key. Verify that the LO BAT indication does not appear. If LO BAT is indicated, the battery will be replaced.
- Place the instrument probe into the calibration solution to a depth of 1 inch or more beyond the vent holes and agitate vertically to release entrapped air bubbles.
- Adjust the displayed reading to the value of the conductivity standard and allow the reading to stabilize.
- Record the display reading in the logbook.
- Press the $^{\circ}\text{C}$ key and record the display reading in the logbook.
- Remove the probe from the solution and rinse thoroughly with distilled water.
- Place the probe into fresh, distilled water and repeat the steps indicated above, recording the appropriate readings. This establishes a zero point or lower bracket reading.
- The instrument is now ready to perform measurements.
- Repackage the instrument and probe in the case for transport.

Note. In the field the instrument will be standardized against an appropriate 10,000 or 1,000 $\mu\text{S}/\text{cm}$ standard solution

A.7 STANDARDIZATION INSTRUCTIONS FOR THE HACH DIGITAL TITRATOR AND HARDNESS TITRANT REAGENT USED FOR THE FIELD MEASUREMENT OF HARDNESS*

Standardization of the digital titrator with EDTA reagent (0.800 M) shall be done monthly or each time a new lot of reagent is received. The standardization procedure will be accomplished as follows

- Attach a clean 90° delivery tube to a 0.800M EDTA Titration Cartridge. Twist the cartridge onto the titrator body. Hold the Digital Titrator with the tip pointing up. Flush out the air in the delivery tube by turning the delivery knob until a few drops of titrant are ejected from the tube and no visible air remains in the cartridge. Reset the counter to zero and wipe the tip. Attach the digital titrator to the laboratory stand.
- Using a graduated cylinder measure 20 ml of the Calcium Standard Solution, 1000 mg/l as CaCO_3 .
- Transfer this solution into a clean 50 ml beaker containing a magnetic stir bar.
- Turn on the magnetic stirrer and maintain a rate so as to minimize the surface disturbance of the sample.
- Add 2 ml of Hardness 1 Buffer Solution and swirl to mix.
- Add the contents of one ManVer 2 Hardness Indicator Powder Pillow and swirl to mix. The color of the solution should turn to wine red.
- Place the delivery tube tip into the solution and titrate the sample until the color changes from red to blue. Titrate slowly toward the end point as it takes time for the reaction and color change to take place, especially in cold water. A limit of 5 minutes is set for the duration of the titration to minimize the tendency toward CaCO_3 precipitation.

- Read the concentration of total hardness (as mg/l CaCO_3) from the digital counter.
- Record this result in the base lab notebook.
- If the value is not within ± 10 percent of the hardness standard, then either the reagent concentration is not correct or the digital titrator is not dispensing accurately. The problem must be resolved and corrected. Acceptable titration to within ± 10 percent of the hardness standard will be obtained before the titrator and EDTA reagent is to be used.

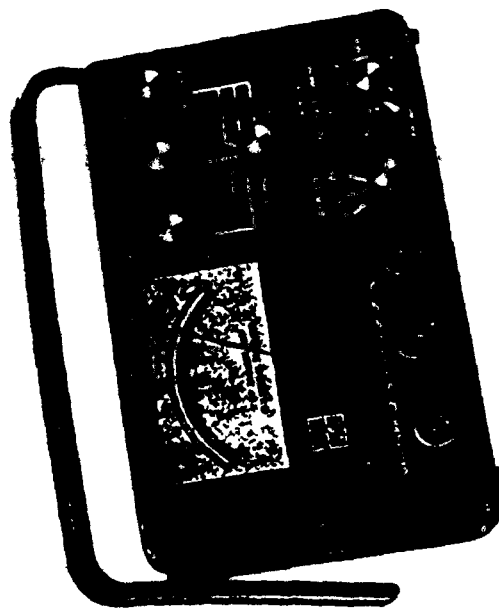
APPENDIX SW2B

**INSTRUCTION MANUAL FOR YSI MODEL 57
DISSOLVED OXYGEN METER**

INSTRUCTION MANUAL

YSI MODEL 57

DISSOLVED OXYGEN METER



YSI Incorporated

Yellow Springs Instrument Co., Inc., Yellow Springs, Ohio 45387 USA

Phone 513 767-7241 / 800 343-HELP / Fax 513 767-9353 / Telex 205437

SUMMARY OF OPERATING INSTRUCTIONS

1 CALIBRATION

- A Switch instrument to OFF and adjust meter mechanical zero
- B Switch to RED LINE and adjust
- C Prepare probe for operation, plug into instrument wait up to 15 minutes for probe to stabilize Probe can be located in calibration chamber (see instruction manual) or ambient air
- D Switch to ZERO and adjust
- E Adjust SALINITY knob to FRESH
- F Switch to TEMP and read
- G Use probe temperature and true local atmospheric pressure (or feet above sea level) to determine correct calibration values from Table I and II (See pages 13 and 14)

EXAMPLE Probe temperature = 21°C. Altitude = 1000 feet From Table I the calibration value for 21°C is 8.9 mg/l From Table II the altitude factor for 1000 feet is approximately .96 The correct calibration value is

$$8.9 \text{ mg/l} \times .96 \text{ factor} = 8.54 \text{ mg/l}$$

- H Switch to desired dissolved oxygen range 0-5 0-10 or 0-20 and with calibrate control adjust meter to correct calibration value determined in Step G

NOTE It is desirable to calibrate probe in a high humidity environment See instruction manual for more detail on calibration and other instrument and probe characteristics

2 MEASUREMENT

- A Adjust the SALINITY knob to the salinity of the sample
- B Place the probe and stirrer in the sample and switch the STIRRER control to ON
- C When the meter has stabilized switch to the appropriate range and read D O
- D We recommend the instrument be left on between measurements to avoid necessity for repolarizing the probe

3. GENERAL CARE

- A Replace the instrument batteries when unable to adjust to red line Use (2) Eveready No 935 "C" size or equivalent
- B In the BATT CHECK position the voltage of the stirrer batteries is displayed on the red 0-10 scale Do not discharge below 8.0 Volts Recharge for 14-16 hrs with YSI No 5728 charger
- C Membrane will last indefinitely, depending on usage Average replacement is 2-4 weeks Probe should be stored in humid environment to prevent drying out
- D Calibrate daily

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GENERAL DESCRIPTION

The YSI Model 57 Dissolved Oxygen Meter is intended for dissolved oxygen and temperature measurement in water and wastewater applications but is also suitable for use in certain other liquids. Dissolved Oxygen is indicated in mg/l (milligrams per liter) on 0-5, 0-10 and 0-20 mg/l scales. Temperature is indicated in °C on a -5° to +45°C scale. The dissolved oxygen ranges are automatically temperature compensated for solubility of oxygen in water and permeability of the probe membrane and manually salinity compensated.

The probes use Clark-type membrane covered polarographic sensors with built in thermistors for temperature measurement and compensation. A thin, permeable membrane stretched over the sensor isolates the sensor elements from the environment, but allows oxygen and certain other gases to enter. When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the absolute pressure of oxygen outside the membrane. If the oxygen pressure increases, more oxygen diffuses through the membrane and more current flows through the sensor. A lower pressure results in less current.

SPECIFICATIONS

I Instrument

Oxygen Measurement

Ranges 0-5, 0-10 and 0-20 mg/l (0-2.5, 0-5 and 0-10 mg/l with YSI 5776 High Sensitivity Membrane)

Accuracy $\pm 1\%$ of full scale at calibration temperature (± 0.1 mg/l on 0-10 scale), or 0.1 mg/l (whichever is larger)

Readability 0.25 mg/l on 0-5 scale, 0.5 mg/l on 0-10 scale, 0.1 mg/l on 0-20 scale

Temperature Measurement

Range -5° to +45°C

Accuracy $\pm 0.5^\circ\text{C}$ plus probe which is $\pm 0.1^\circ\text{C}$

Readability 0.25°C

Temperature Compensation

$\pm 1\%$ of D O reading for measurements made within $\pm 5^\circ\text{C}$ of calibration temperature

$\pm 3\%$ of D O reading over entire range of -5 to +45°C probe temperature

System Response Time

Typical response for temperature and D O readings is 90% in 10 seconds at a constant temperature of 30°C with YSI 5775 Membranes. D O response at low temperature and low D O is typically 90% in 30 seconds. YSI 5776 High Sensitivity Membranes can be used to improve response at low temperature and low D O concentrations. If response time under any operating conditions exceeds two minutes, probe service is indicated.

Operating Temperature Range

Instrument and probe operating range is -5° to +45°C. Large ambient temperature changes will result in 2% loss of accuracy unless Red Line and Zero are reset.

Recorder Output

0 to 114 136 mV. Recorder should have 50 000 ohms minimum input impedance.

Power Supply

The YSI Model 57 is powered by two disposable C size carbon zinc batteries (Eveready 935C or equal) providing approximately 1000 hour operation.

II Probe

Cathode Gold

Anode Silver

Membrane 001 FEP Teflon

(0005 FEP Teflon available)

Electrolyte Half saturated KCl

Temperature Compensation (See SPECIFICATIONS I Instrument)

Pressure Compensation Effective 1/2% of reading with pressures to 100 psi (230 ft sea water)

Polarizing Voltage 0.8 volts nominal

Probe Current Air at 30°C = 19 microamps nominal

Nitrogen at 30°C = 15 microamps or less

III

Accessories and Replacement Parts

YSI 5720A — Self Stirring BOD Bottle Probe

YSI 5750 — Non Stirring BOD Bottle Probe

YSI 5739 — Oxygen Temperature Probe for field use. Combine with one of the following 4 cables for desired lead length.

Detachable leads for use with YSI 5739

YSI 5740-10 10' Cable

YSI 5740-25 25' Cable

YSI 5740-50 50' Cable

YSI 5740-100 100' Cable

YSI 5740-150 150' Cable

YSI 5740-200 200' Cable

YSI 5721 — Battery and charger pack operates YSI 5791A and 5795A

Submersible Stirrers

YSI 5791A — Submersible Stirrer for field use

YSI 5795A — Submersible Stirrer

YSI 5075A — Calibration Chamber for use with field probe.

YSI 5890 — Carrying Case

YSI 5775 — Membrane and KCl Kit Standard — includes 2 each 15 membrane packets (001 thick standard membranes) and a 30 ml bottle KCl with Kodak photo flo

YSI 5776 — Membrane and KCl Kit High Sensitivity — includes 2 each 15 membrane packets (0005 thick membranes) and a 30 ml bottle KCl with Kodak photo flo

YSI 5680 — Probe Reconditioning Kit

YSI 5945 "O" Ring Pack — includes (6) "O" rings for each YSI DO Probe
 YSI 5486 — Beater Boot Kit — includes (1) A-05486 Boot (1) A-05484
 Tip (2) A-05485 Spring Used only on 5720A and discontinued 5420A

YSI 5986 — Diaphragm Kit for use only with YSI 5739 D O Probe
 YSI 5735 — Adaptor makes it possible to use YSI 5739 YSI 5720A and
 YSI 5750 Probes with discontinued YSI Models 51A, 54RC
 and 548P

OXYGEN PROBES AND EQUIPMENT

There are three oxygen probes for use with the YSI Model 57 Dissolved Oxygen Meters. Descriptions of where they are used are contained in the following paragraphs:

1) YSI 5739 D O Probe

The YSI 5739 probe is designed for use with the 5740 detachable cable and replaces the discontinued YSI 5418, 5419, 5718 and 5719 probes. (See Figure 1)

For user convenience the probe is equipped with a disconnecting cable to facilitate changing cable lengths and replacing damaged cables or probes. The probe and cable assembly is held together with a threaded retaining nut. The connection is *not* designed for casual disconnection and should only be disconnected when necessary.

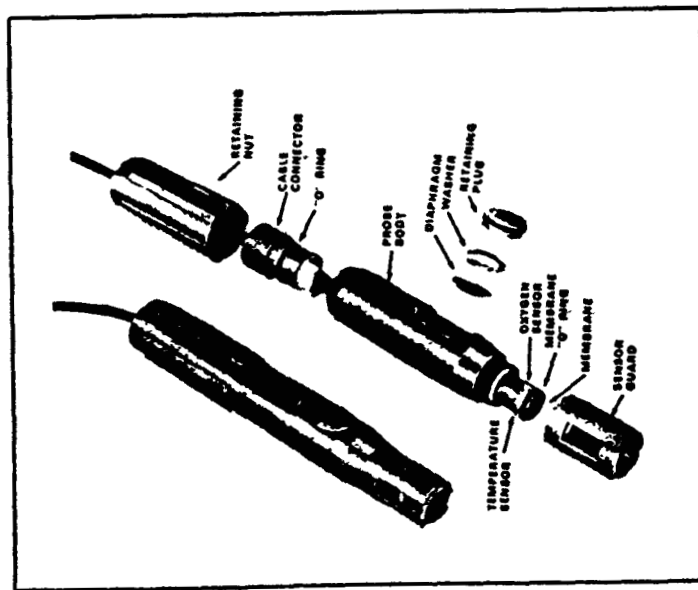


FIGURE 1

disconnect the cable unscrew the retaining nut and slide it down the cable to expose the connector. Pull gently on the cable and connector until the connector comes away from the probe body.

To reassemble inspect the connector and "O" ring for cleanliness. If the "O" ring is frayed or damaged remove it by squeezing it in the groove causing it to bulge then roll it out of the groove and off the connector. A replacement "O" ring is supplied with the cable.

Push the connector into the probe body, rotating it until the two halves mate. A light coating of vaseline or silicone grease on the "O" ring will make reassembly easier. Air trapped between the connector halves which may cause them to spring apart slightly, is normal. Screw on the retaining nut, *hand tight only*. NOTE: If erratic readings are experienced, disconnect the cable and inspect for water. If present dry out and reconnect, replacing the "O" ring if necessary.

Pressure Compensation

The vent on the side of the probe is part of a unique pressure compensating system that helps assure accurate readings at great depths of water. Pressure compensation is effective to 1/2% of reading with pressures to 100 psi (230 ft water). The quantity of air bubbles trapped under the membrane determines how serious the pressure error will be, which is why proper preparation of the probe is essential. (See OPERATING PROCEDURES). The system is designed to accommodate a small amount of trapped air and still function properly, but the amount should be kept to a minimum.

The compensating system normally does not require servicing and should not be taken apart. However, if electrolyte is leaking through the diaphragm or if there is an obvious puncture, the diaphragm must be replaced. A spare is supplied with the probe. Using a coin unscrew the retaining plug and remove the washer and the diaphragm, flush any salt crystals from the reservoir, install the new diaphragm (convolution side in), replace the washer, and screw in the retaining plug.

II. YSI 5720A B O D Bottle Probe

The YSI 5720A B O D Bottle Probe replaces the discontinued YSI 5420A B O D Bottle Probe for measuring dissolved oxygen and temperature in standard B O D bottles. It is provided with an agitator for stirring the sample solution, available in models for 117VAC (95-135VAC, 50-60 Hz) or 230VAC (190-250VAC, 50-60 Hz) operation. (See Figure 2)

When using the probe, plug the agitator power supply into line power and the probe plug into the instrument. With the agitator turned off place the tapered probe end into the B O D bottle and switch agitator ON with switch on top of probe. The probe should be operated with a minimum of trapped air in the B O D bottle. A slight amount of air in the unstirred region at the top of the bottle may be neglected, but no bubbles should be around the thermistor or oxygen sensor.

Stirrer Boot

The probe uses a flexible stirring boot to transmit motion from the sealed motor housing to the sample. If the boot shows signs of cracking or other damage likely to allow leaking into the motor housing, the boot must be replaced.

In fresh water applications boot life is normally several years, but this may be shortened by exposure to hydrocarbons, moderate to strong acids or bases.

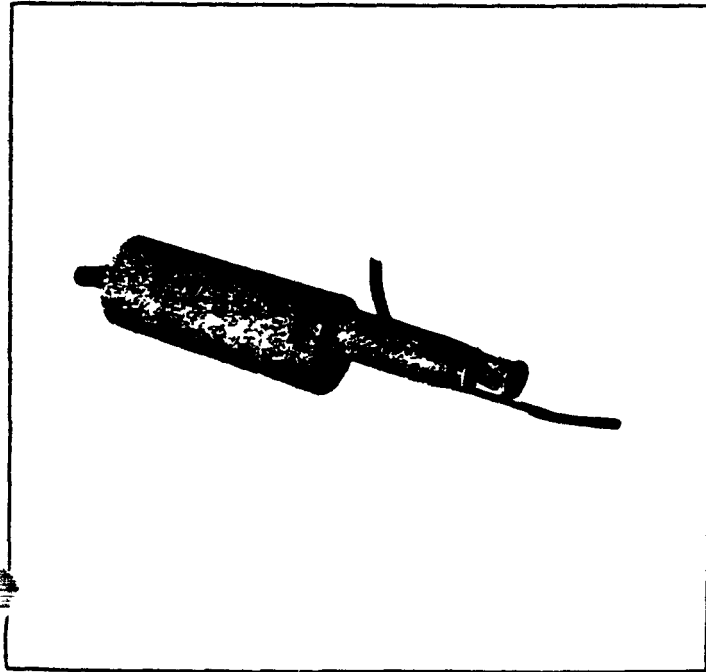


FIGURE 2

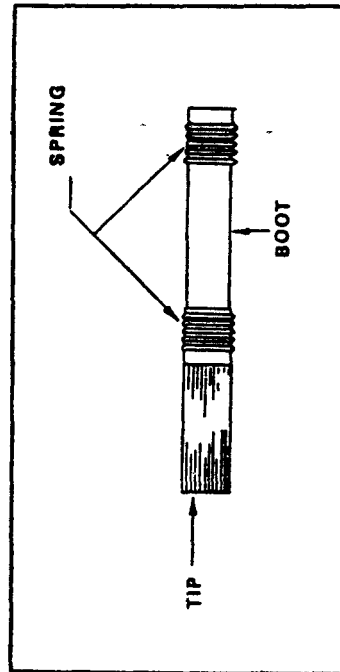


FIGURE 3

ozone or direct sunlight. For maximum life, rinse the boot after use in contaminated samples. (See Figure 3)

Boot replacement is as follows:

1. Pull off old assembly and clean shaft.
2. Slide on new assembly making sure the back spring is on the grooved area of the shaft. A small amount of rubber cement may be used.
3. Check that there is sufficient clearance between the tip and the end of the shaft to permit turning without binding.

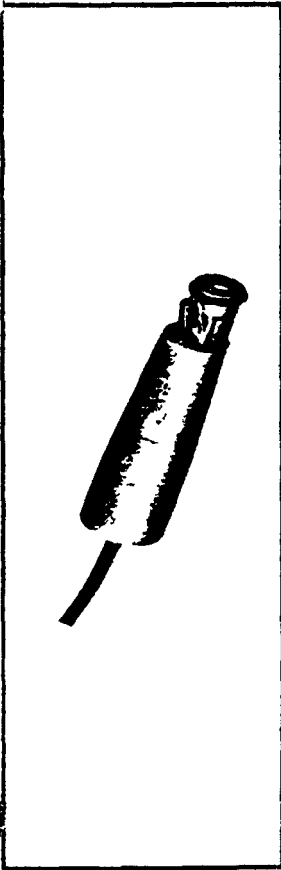


FIGURE 4

III YSI 5750 BOD Bottle Probe

The YSI 5750 BOD Bottle Probe replaces the discontinued YSI 5450 BOD Bottle Probe. It is similar to the YSI 5720A BOD Bottle Probe except that it does not have a stirrer. Agitation of the sample must be provided by other means, such as a magnetic stirrer. (See Figure 4)

IV Cable Adaptors

All YSI 5700 Series Probes are designed for direct use with the YSI Model 57 Dissolved Oxygen Meter.

V YSI 5791A and 5795A Submersible Stirrers

The YSI submersible stirrers are accessories that perform the function of stirring the sample being studied when making dissolved oxygen measurements in the field. The YSI 5791A stirrer can be used with the following dissolved oxygen probes: YSI 5418, 5419, 5718, 5719, and 5739. The YSI 5795A stirrer is only for use with the YSI 5739 Probe. (See Figure 5)

When a stirrer and probe are assembled, the stirrer agitates the sample directly in front of the sensor by means of a rotating eccentric weight which causes the spring-mounted hermetically sealed motor housing to vibrate. An impeller on the end of the motor housing flushes the media across the oxygen sensor. (See sales literature and instruction sheets for further information)

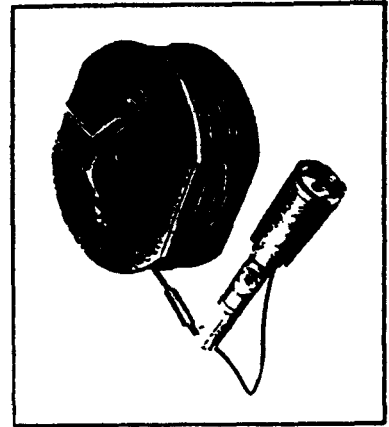


FIGURE 5

VI YSI 5721 Battery Pack and Charger

The YSI 5721 Battery Pack and Charger is offered as an accessory to operate either the YSI 5791A or 5795A Submersible Stirrer when the stirrer is used in conjunction with the YSI Model 57 Oxygen Meter. The YSI 5721 can be purchased with the YSI Model 57 or installed at a later time (See sales literature and instruction sheet for further information)

OPERATING PROCEDURES

I Preparing the Probe

All YSI 5700 Series Probes have similar sensors and should be cared for in the same manner. They are precision devices relying on good treatment if high accuracy measurements are to be made. Prepare the probes as follows (See Figure 6)

ALL PROBES ARE SHIPPED DRY — YOU MUST FOLLOW THESE INSTRUCTIONS

- 1 Prepare the electrolyte by dissolving the KCl crystals in the dropper bottle with distilled water. Fill the bottle to the top.
- 2 Unscrew the sensor guard from the probe (YSI 5739 only) and then remove the O' ring and membrane. Thoroughly rinse the sensor with KCl solution.
- 3 Fill the probe with electrolyte as follows

A Grasp the probe in your left hand. When preparing the YSI 5739 probe the pressure compensating vent should be to the right. Successively fill the sensor body with electrolyte while pumping the diaphragm with the eraser end of a pencil or similar soft blunt tool. Continue filling and pumping until no more air bubbles appear. (With practice you can hold the probe and pump with one hand while filling with the other.) When preparing the YSI 5720A and 5750 probes simply fill the sensor body until no more air bubbles appear.

B Secure a membrane under your left thumb. Add more electrolyte to the probe until a large meniscus completely covers the gold cathode.

NOTE Handle membrane material with care keeping it clean and dust free touching it only at the ends.

C With the thumb and forefinger of your other hand grasp the free end of the membrane.

D Using a continuous motion *stretch* the membrane *UP, OVER*, and *DOWN* the other side of the sensor. Stretching forms the membrane to the contour of the probe.

E Secure the end of the membrane under the forefinger of the hand holding the probe.

F Roll the O' ring over the end of the probe. There should be no wrinkles in the membrane or trapped air bubbles. Some wrinkles may be removed by lightly tugging on the edges of the membrane beyond the O' ring.

G Trim off excess membrane with scissors or sharp knife. Check that the stainless steel temperature sensor is not covered by excess membrane.

4 Shake off excess KCl and reinstall the sensor guard.

5 A bottomless plastic bottle is provided with the YSI 5739 probe for convenient storage. Place a small piece of moist towel or sponge in the bottle and insert the probe into the open end. This keeps the electrolyte from drying out. The YSI 5720A and 5750 probes can be stored in a B O D bottle containing about 1' water.

Membranes will last indefinitely, depending on usage. Average replacement is 2-4 weeks. However, should the electrolyte be allowed to evaporate and an excessive amount of bubbles form under the membrane, or the membrane become damaged, thoroughly flush the reservoir with KCl and install a new membrane.

7 Also replace the membrane if erratic readings are observed or calibration is not stable.

8 "Home brew" electrolyte can be prepared by making a saturated solution of reagent grade KCl and distilled water, and then diluting the solution to half strength with distilled water. Adding two drops of Kodak Photo Flo per 100 ml of solution assures good wetting of the sensor, but is not absolutely essential.

9 The gold cathode should always be bright and untarnished. If it is tarnished (which can result from contact with certain gases) or plated with silver (which can result from extended use with a loose or wrinkled membrane), return it to the factory for service or else clean it with the YSI 5680 Probe Reconditioning Kit. Never use chemicals or any abrasive other than that supplied with this kit.

10 It is also possible that the silver anode may become contaminated, which will prevent successful calibration. Try soaking the probe overnight in a 3% ammonia solution, rinse with deionized water, recharge with electrolyte, and install a new membrane. If still unable to calibrate, return the probe for service.

11 H₂S, SO₂, Halogens, Neon, Nitrous Oxide and CO are interfering gases. If you suspect erroneous readings, it may be necessary to determine if these are the cause. These gases have been tested for response:

100% Carbon Monoxide-Less than 1%	100% Helium-none
100% Carbon Dioxide-Around 1%	100% Nitrous Oxide-1/3 O ₂ response
100% Hydrogen-Less than 1%	100% Ethylene-none
100% Chlorine-2/3 O ₂ response	100% Nitric Oxide-1/3 O ₂ response

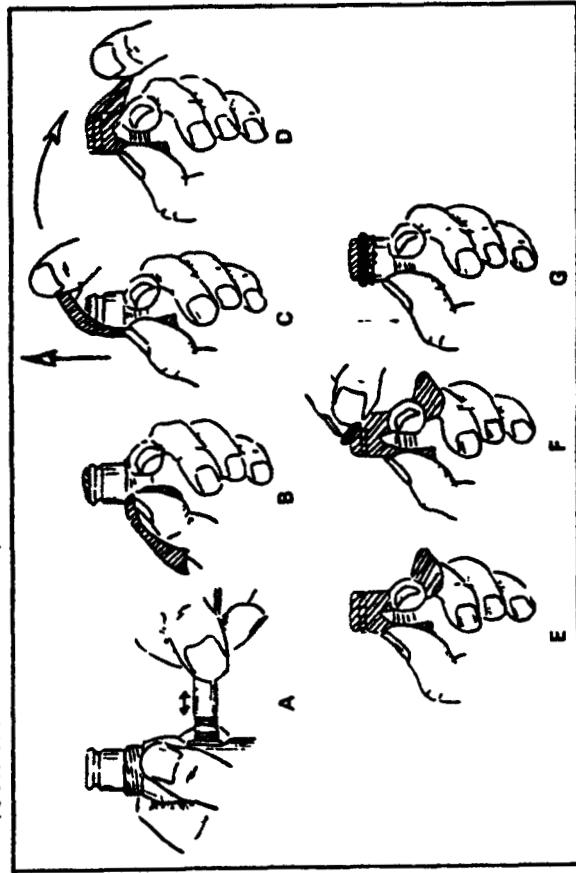


FIGURE 6

II Preparing the Instrument

It is important that the instrument be placed in the intended operating position vertical tilted or on its back — before it is prepared for use and calibrated (See Figure 7) Readjustment may be necessary when the instrument operating position is changed After preparing the probe proceed as follows

- 1 With switch in the OFF position, adjust the meter pointer to Zero with the screw in the center of the meter panel Readjustment may be necessary if the instrument position is changed
- 2 Switch to RED LINE and adjust the RED LINE knob until the meter needle aligns with the red mark at the 31°C position
- 3 Switch to ZERO and adjust to zero with zero control knob
- 4 Attach the prepared probe to the PROBE connector of the instrument and adjust the retaining ring finger tight
- 5 Before calibrating allow 15 minutes for optimum probe stabilization Repolarize whenever the instrument has been OFF or the probe has been disconnected

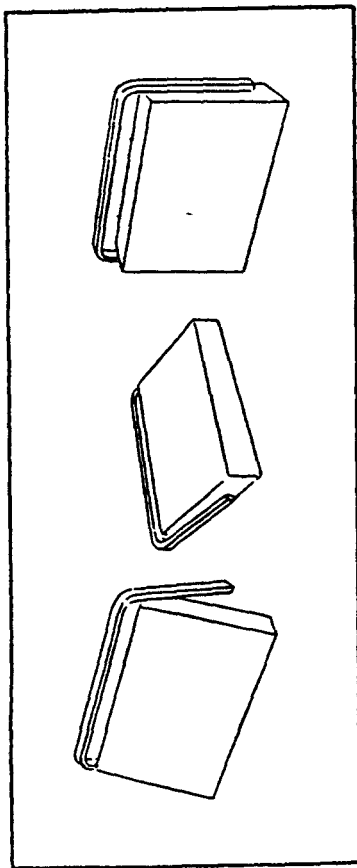


FIGURE 7

III Calibration

The operator has a choice of three calibration methods — Winkler Titration Saturated Water and Air Experience has shown that air calibration is quite reliable yet far simpler than the other two methods The three methods are described in the following paragraphs

Winkler Titration

- 1 Draw a volume of water from a common source and carefully divide into four samples Determine the oxygen in three samples using the Winkler Titration technique and average the three values If one of the values differs from the other 2 by more than 0.5 mg/l, discard that value and average the remaining two
- 2 Place the probe in the fourth sample and stir
- 3 Set the SALINITY control to zero or the appropriate salinity value of the sample
- 4 Switch to desired mg/l range and adjust the CALIBRATION control to the average value determined in Step 1 Allow the probe to remain in the sample for at least two minutes before setting the calibration value and leave in the sample for an additional 2 minutes to verify stability Readjust if necessary

Saturated Water

- 1 Air saturate a volume of water (300-500cc) by aerating or stirring for at least 15 minutes at a relatively constant temperature
 - 2 Place the probe in the sample and stir Switch to TEMPERATURE Refer to Calibration Table I for the mg/l value corresponding to the temperature
 - 3 Determine local altitude or the true atmospheric pressure (note that true atmospheric pressure is as read on a mercury barometer Weather Bureau reporting of atmospheric pressure is corrected to sea level) Using Table II determine the correct factor for your pressure or altitude
 - 4 Multiply the mg/l value from Table I by the correction factor from Table II to determine the corrected calibration value for your conditions
- EXAMPLE** Assume temperature = 21°C and altitude = 1000 feet From Table I the calibration value for 21°C is 8.9 mg/l From Table II the correction factor for 1000 feet is about 0.96 The corrected calibration value is $8.9 \text{ mg/l} \times 0.96 = 8.54 \text{ mg/l}$
- 5 Switch to an appropriate mg/l range, set the SALINITY knob to zero and adjust the CALIBRATE knob while stirring until the meter reads the corrected calibration value from Step 4 Leave the probe in the sample for two minutes to verify calibration stability Readjust if necessary

Air Calibration

- 1 Place the probe in moist air BOD probes can be placed in partially filled (50 mL) BOD bottles Other probes can be placed in the YSI 5075A Calibration Chamber (refer to the following section describing calibration chamber) or the small storage bottle (the one with the hole in the bottom) along with a few drops of water The probe can also be wrapped loosely in a damp cloth taking care the cloth does not touch the membrane Wait approximately 10 minutes for temperature stabilization

- 2 Switch to TEMPERATURE and read Refer to Table I — Solubility of Oxygen in Fresh Water and determine calibration value

- 3 Determine altitude or atmospheric correction factor from Table II

- 4 Multiply the calibration value from Table I by the correction factor from Table II

EXAMPLE Assume temperature = 21°C and altitude = 1000 feet From Table I the calibration value for 21°C is 8.9 mg/l From Table II the correction factor for 1000 feet is about 0.96 Therefore, the corrected calibration value is $8.9 \text{ mg/l} \times 0.96 = 8.54 \text{ mg/l}$

- 5 Switch to the appropriate mg/l range, set the SALINITY knob to zero and adjust the CALIBRATE knob until the meter reads the correct calibration value from Step 4 Wait two minutes to verify calibration stability Readjust if necessary

The probe is now calibrated and should hold this calibration value for many measurements Calibration can be disturbed by physical shock touching the membrane or drying out of the electrolyte Check calibration after each series of measurements and in time you will develop a realistic schedule for recalibration For best results when not in use follow the storage procedures recommended for the various probes described under OXYGEN PROBES AND EQUIPMENT This will reduce drying out and the need to change membranes

Calibration Chamber

The YSI 5075A Calibration Chamber is an accessory that helps obtain optimum calibration in the field and is also a useful tool for measuring at shallow depths (less than 4')

As shown in Figure (A), it consists of a 4-1/2 foot stainless steel tube (1) attached to the calibration chamber (2), the measuring ring (3), and two stoppers (4) and (5)

For calibration, insert the solid stopper (4) in the bottom of the calibration chamber (2). Push the oxygen probe (6) through the hollow stopper (5) as shown in Figure (B). Place the probe in the measuring ring, Figure (C) and immerse the probe in the sample to be measured for five minutes to thermally equilibrate the probe. Quickly transfer the probe to the calibration chamber (5) draining excess water from the chamber and shaking any excess droplets from the probe membrane. For maximum accuracy wet the inside of the calibration chamber with fresh water. This creates a 100% relative humidity environment for calibration. Place the chamber in the sample for an additional five minutes for final thermal equilibrium. Calibrate the probe as described in the air-calibration procedure. Keep the handle above water at all times.

After calibration return the probe to the measurement ring for shallow measurements. Move the probe up and down, or horizontally, approximately one foot a second while measuring in rapidly flowing streams (greater than 5/sec.) install the probe in the measuring ring with the pressure compensating diaphragm towards the chamber.

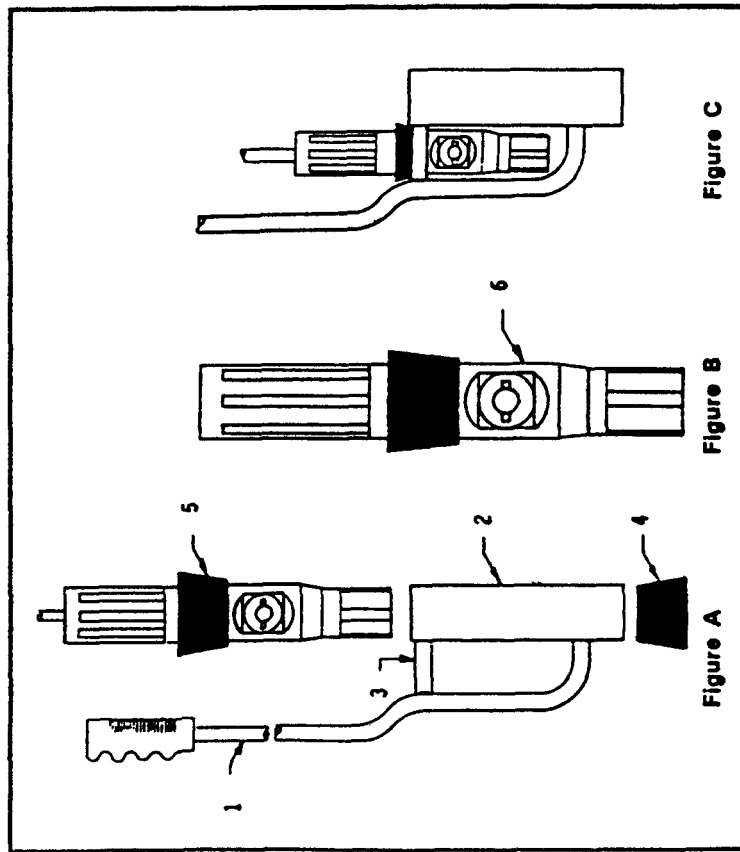


FIGURE 8

Dissolved Oxygen Measurement

With the instrument prepared for use and the probe calibrated, place probe in the sample to be measured and provide stirring

- 1 Stirring for the 5739 Probe can best be accomplished with a YSI submersible stirrer. Turn the STIRRER knob ON. If the submersible stirrer is not used, provide manual stirring by raising and lowering the probe about 1 ft per second. If the 5075A Calibration Chamber is used, the entire chamber may be moved up and down in the water at about 1 ft per second
- 2 The YSI 5720A has a built in power driven stirrer
- 3 With the YSI 5750 sample stirring must be accomplished by other means such as with the use of a magnetic stirring bar
- 4 Adjust the SALINITY knob to the salinity of the sample
- 5 Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen. Read dissolved oxygen

V Calibration Tables

Table I shows the amount of oxygen in mg/l that is dissolved in air saturated fresh water at sea level (760 mmHg atmospheric pressure) as temperature varies from 0° to 45°C

Table I — Solubility of Oxygen in Fresh Water

Temperature °C	mg/l Dissolved Oxygen	Temperature °C	mg/l Dissolved Oxygen
0	14.60	23	8.58
1	14.19	24	8.40
2	13.81	25	8.24
3	13.44	26	8.09
4	13.09	27	7.95
5	12.75	28	7.81
6	12.43	29	7.67
7	12.12	30	7.54
8	11.83	31	7.41
9	11.55	32	7.28
10	11.27	33	7.16
11	11.01	34	7.05
12	10.76	35	6.93
13	10.52	36	6.82
14	10.29	37	6.71
15	10.07	38	6.61
16	9.85	39	6.51
17	9.65	40	6.41
18	9.45	41	6.31
19	9.26	42	6.22
20	9.07	43	6.13
21	8.90	44	6.04
22	8.72	45	5.95

Source Derived from 15th Edition "Standard Methods for the Examination of Water and Wastewater"

Table II shows the correction factor that should be used to correct the calibration value for the effects of atmospheric pressure or altitude. Find true atmospheric pressure in the left hand column and read across to the right hand column to determine the correction factor (Note that true atmospheric pressure is as read on a barometer Weather Bureau reporting of atmospheric pressure is corrected to sea level.) If atmospheric pressure is unknown the local altitude may be substituted. Select the altitude in the center column and read across to the right hand column for the correction factor.

Table II — Altitude Correction Factor

Atmospheric Pressure mmHg	or	Equivalent Altitude Ft	Correction Factor
775		540	1.02
760		0	1.00
745		542	.98
730		1094	.96
714		1688	.94
699		2274	.92
684		2864	.90
669		3466	.88
654		4082	.86
638		4756	.84
623		5403	.82
608		6065	.80
593		6744	.78
578		7440	.76
562		8204	.74
547		8939	.72
532		9694	.70
517		10472	.68
502		11273	.66

Source Derived from 15th Edition "Standard Materials for the Examination of Water and Wastewater."

VI HIGH SENSITIVITY MEMBRANE

Use of high sensitivity 0005 membranes (YSI 5776) in place of standard 001 membranes (YSI 5775) when measurements are to be made consistently at low temperatures (less than 15°C). Calibration and readings will be made just as if the standard YSI 5775 membrane was being used.

The YSI 5776 High Sensitivity Membrane can also be used in certain situations to increase sensitivity at temperatures above 15°C. The ranges thus become 0-2.5, 0-5 and 0-10 mg/l. When calibration with high sensitivity membranes is attempted at temperatures greater than 15°C the selector switch must be set to 0-20 mg/l. Multiply the calculated calibration value by 2. For example at 21°C and 1000 ft altitude the calibration value would be 8.6 x 2 or 17.2. Remember the 0-5, 0-10 and 0-20 mg/l ranges are now 0-2.5, 0-5 and 0-10 mg/l, and all mg/l readings must be divided by 2 for a final reading. When operating in this manner accuracy will be degraded slightly.

RECORDER OUTPUT

Output at full scale is 114 to 136 mV

Use a 50K or higher input impedance recorder and operate it with the terminals ungrounded.

Many recorders have an adjustable full scale sensitivity feature. When using this type use the 100 mV range and adjust the full scale (span range control, sensitivity etc.) control to give full scale chart deflection with full scale oxygen meter deflection. Refer to the recorder instructions. For recorders without this feature a simple driver network as shown below can be constructed. This is adequate to adjust the signal for full scale chart and meter deflection on the 100 mV fixed range recorders.

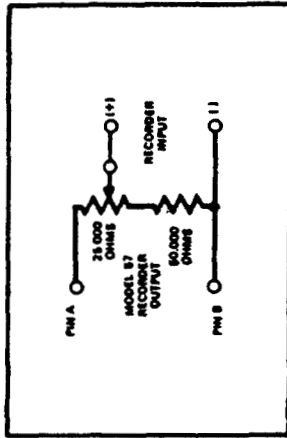


FIGURE 9

Recorder Output Plug

The YSI Model 57 is supplied with the necessary parts to construct a waterproof recorder plug for the YSI Model 57 Dissolved Oxygen Meter. The cable and potting materials are not included (See Figure 10).

General purpose epoxy potting materials of medium viscosity and moderate cure rate are recommended. The two tube kits available in hardware stores are satisfactory.

- 1 Prepare the cable end by stripping back 3/16" (5MM) of insulation. Tin the ends with rosin core solder. If polarity is important pin "A" is the (+) terminal.
- 2 Disassemble the connector pieces and slide the mold, ring, extension, and coupling nut over the cable. Solder the leads to the appropriate connector pins with rosin core solder.
- 3 Check all connections. The two leads should show electrical continuity to the pins and should not contact the body or each other.
- 4 Re-assemble the pieces and hold the connector upright. Pour the epoxy mix into the plastic mold until full. Refill as the epoxy settles.
- 5 After the epoxy cures the plastic mold may be removed with pliers or knife.

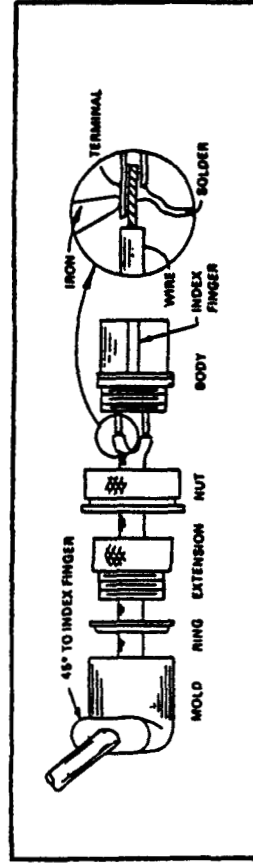


FIGURE 10

DISCUSSION OF MEASUREMENT ERRORS

There are three basic types of errors which can occur. Type I errors are related to limitations of the instrument design and tolerances of the instrument components. These are chiefly the meter linearity and resistor tolerances. Type II errors are due to basic probe accuracy tolerances, chiefly background signal probe linearity and variations in membrane temperature coefficient. Type III errors are related to the operator's ability to determine the conditions at the time of calibration. If calibration is performed against more accurately known conditions, Type III errors are appropriately reduced.

Individual Sources of Error

This description of sources of error can be used to attach a confidence to any particular reading of dissolved oxygen. The particular example given is for a near extreme set of conditions. As a generality, overall error is diminished when the probe and instrument are calibrated under conditions of temperature and dissolved oxygen which closely match the sample temperature and dissolved oxygen.

Type I

A Is the error due to the meter linearity

Error = $\pm 1\%$ of full scale of the measurement range

B Is the error due to tolerances in the instrument when transferring a reading from one range to another

Error = $\pm 1\%$ of the meter reading if the reading is taken on a range one range away from the calibration range

Error = $\pm 2\%$ of the meter reading if the reading is taken on a range two ranges away from the calibration range

C Is the error due to the design and components of the instrument salinity compensation circuit

Error = $\pm 2.5\%$ of the meter reading $\times \frac{\text{sample salinity ppt}}{40 \text{ ppt salinity}}$

Type II

A errors are due to probe background current

Error = $0.5\% \left(\frac{\text{meter reading mg/l}}{1 - \text{Calib value}} \right) \times \text{Calib value, mg/l}$

B errors are due to the probe non-linearity

Error = 0.3% of reading

C error is caused by variability in the probe membrane temperature coefficient. Error = zero if readings are taken at the calibration temperature

Error = $\pm 1\%$ of meter reading if readings are taken with 5°C of the calibration temperature

Error = $\pm 3\%$ of meter reading all other conditions

Type III

A errors are due to the accuracy of the instrument thermometer when used to measure the exact probe temperature during calibration

Error = $\pm 1.5\%$ of reading

B errors are due to the assumption of mean, barometric pressure

Daily variation is usually less than 1.7%

Error = $\pm 1.7\%$ of reading

errors assume an ability to estimate altitude to within ± 500 ft when putting the altitude correction factor

Error = 1.8% of reading

D errors consider the possibility of only 50% relative humidity when calibrating the probe. If the actual relative humidity is 50% instead of 100% the errors will be as follows

Calibration Temperature $\pm C$	Error in Percent of Reading
0	(-) 0.3
10	(-) 0.6
20	(-) 1.15
30	(-) 2.11
40	(-) 3.60

Example of a Typical Error Calculation

The example given presumes the air calibration technique. If calibration is done with air saturated water, the relative humidity consideration (III-D) is eliminated. If the Winkler calibration method is used, Type III errors are deleted and replaced by the uncertainty attributable to the overall Winkler determination. Data Instrument calibrated at 25°C , elevation estimated at 2000 feet ± 500 feet, normal barometric pressure presumed calibrated on $0-10$ mg/l scale at 7.8 mg/l. Readings taken on $0-5$ mg/l range at 4.5 mg/l, temperature 20°C Salinity of 20 ppt

Type	Description	Calculations	Error mg/l
IA	Linearity	$= 01 \times 4.5 \text{ mg/l}$	0.45
IB	Range Change	$= 01 \times 4.5 \text{ mg/l}$	0.45
IC	Salinity	$= 025 \times 4.5 \text{ mg/l} \times 40 \text{ ppt}$	0.56
IIA	Probe Background	$= 005 \times \left(1 - \frac{4.5 \text{ mg/l}}{7.8 \text{ mg/l}} \right) \times 7.8 \text{ mg/l}$	0.16
IIB	Probe Linearity	$= 003 \times 4.5 \text{ mg/l}$	0.14
IIC	Temp Compensation	$= 01 \times 4.5 \text{ mg/l}$	0.45
IIIA	Temp Measurement	$= 015 \times 4.5 \text{ mg/l}$	0.68
IIIB	Pressure	$= 017 \times 4.5 \text{ mg/l}$	0.76
IIIC	Altitude	$= 018 \times 4.5 \text{ mg/l}$	0.81
IIID	RH	$= 016 \times 4.5 \text{ mg/l}$	0.72
Maximum Possible Error			$= 5.18 \text{ mg/l}$
Probable Error			± 2.59

Considering a statistical treatment of the probable error at any time for any instrument, it is likely that the actual error in any measurement will be about $1/2$ of the possible error. In this case the probable error is about ± 2.6 mg/l out of a reading of 4.5 mg/l or 5.8% of the reading.

INSTRUMENT CASE

The instrument case is water resistant when properly closed. As a precaution against damaged gaskets or loose fittings, the instrument case should be opened and inspected for moisture whenever the instrument has been subjected to immersion or heavy spray. The instrument case is opened by removing the screws on the rear cover and lifting the cover off.

INSTRUMENT BATTERIES

The instrument batteries are two "C" size carbon-zinc cells located inside the instrument on the meter end. These should be replaced when the RED LINE knob is at its extreme adjustment or at least annually. The amount of remaining adjustment is an indication of the battery condition. The batteries are replaced by removing the screws on the rear cover of the instrument and removing the two batteries at the end of the instrument near the meter. When installing the new batteries the plus (+) end fits into the red washer on the battery holder. (See Figure 11)

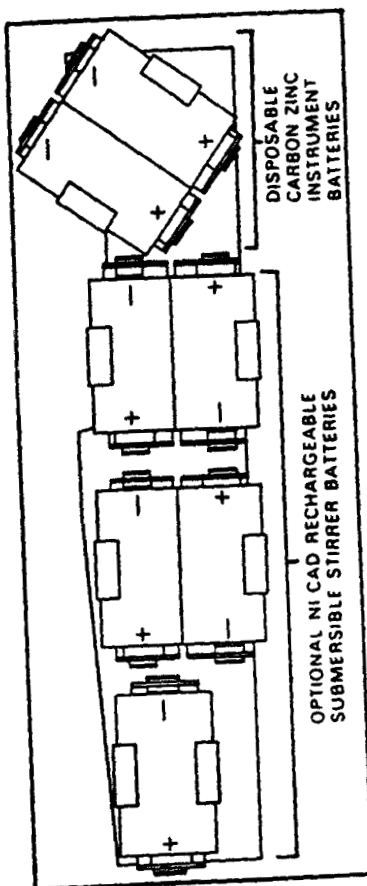


FIGURE 11

WARRANTY AND REPAIR

All YSI products carry a one-year warranty on workmanship and parts, exclusive of batteries. Damage through accident, misuse, or tampering will be repaired at a nominal charge, if possible, when the item is returned to the factory or to an authorized YSI dealer.

If you are experiencing difficulty with any YSI product, it may be returned for repair, even if the warranty has expired. YSI maintains complete facilities for prompt servicing for all YSI products.

PRODUCT SERVICE DEPARTMENT

YSI INCORPORATED

P O BOX 279

YELLOW SPRINGS, OHIO 45387, U S A.

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Category 2	Organization.	Environmental Management

TITLE
SURFACE WATER SAMPLING

Approved By

(Name of Approver)

MAY 12, 1992

(Date)

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REVIEWED FOR CLASSIFICATION/UCNI

By

Date

H. L. Jones
March 9, 1992

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes sampling procedures, documentation, and equipment that will be used to collect water quality samples from surface water data collection sites at Rocky Flats Plant (RFP). More than one sampling method is required because flow conditions vary from site to site. In consideration of these varied conditions, this SOP describes methods that are to be used based on the site-specific flow conditions.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

The project manager or task leader is responsible for assigning project staff to complete surface water data collection activities at the RFP. The task leader is also responsible for ensuring that this and other appropriate procedures are followed by project personnel.

Personnel sampling surface water will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

Kister, L. R. and W. B. Garrett. Field Guidelines for Collection, Treatment, and Analysis of Water Samples-Arizona District. U.S. Geological Survey, Water Resources Division. November 1984.

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Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846 EPA September 1986

U S Department of Energy The Environmental Survey Manual DOE/EH-0053, Washington, D C August 1987

U S Department of the Interior National Handbook for Recommended Methods for Water-Data Acquisition Office of Water Data Coordination, Geological Survey Reston, VA 1977

U S Environmental Protection Agency Standard Operating Procedures and Quality Assurance Manual Environmental Services Division, Region VIII. Athens, GA January, 1988

NPDES/FFCA Operations Sampling Plan Environmental Management Surface Water Division, Rocky Flats (In Progress)

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows

- SOP FO.3, General Equipment Decontamination
- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP SW 1, Surface Water Data Collection Activities
- SOP SW.2, Field Measurement of Surface Water Parameters
- SOP SW 4, Discharge Measurements
- SOP SW 8, Pond Sampling
- SOP SW 9, Industrial Effluent and Pond Discharge Sampling

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5.0 METHODS

Surface water flow conditions vary geographically and seasonally. Therefore, the following list will be used as a guideline in identifying techniques of sampling which will correspond to the sample site flow conditions. This list is based upon the most often observed flow conditions at the RFP surface water sites. If field sampling crews encounter flow conditions not described under any of the listed categories, they will use their best judgement in varying one of the approved techniques in order to obtain samples. The technicians will carefully document the site conditions which necessitated deviation from the approved methods and will also carefully note the method used to obtain the samples.

The flow conditions which have been most frequently encountered, and sections of this SOP containing methods to be used at these sites, are

1 Flowing, channelized streams

The sampler will use methods described in Subsection 5.3.2, Samples Collected by Container Immersion.

2 Pipes

Depending on site conditions, use Subsection 5.3.3, Sampling of Standing Water, Subsection 5.3.4, Remote Sampling; or Subsection 5.3.5, Sampling Under Low Flow Conditions. If the pipe discharges sufficient volume into a channelized stream, use Subsection 5.3.2, Samples Collected by Container Immersion or as described in SOP SW 9, Industrial Effluent and Pond Discharge Sampling. The sample container should not contact the pipe in order to avoid mobilizing

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materials which may be loosely attached to the pipe causing these materials to contaminate the sample

3 Small ponds

The sampler will use Subsection 5.3.3, Sampling of Standing Water or Subsection 5.3.4, Remote Sampling

4 Interceptor ditches

Samples may be obtained by methods described in Subsection 5.3.3, Sampling of Standing Water, Subsection 5.3.4, Remote Sampling or Subsection 5.3.5, Sampling Under Low Flow Conditions, or Subsection 5.3.2, Samples Collected by Container Immersion, depending on conditions

5 Sumps or Standpipes

These will typically contain low volumes of water, and are sampled by methods detailed in Subsection 5.3.3, Sampling of Standing Water or Subsection 5.3.4, Remote Sampling

6 Low Flow Conditions

Samples will be obtained in accordance with Subsection 5.3.5, Sampling Under Low Flow Conditions

7 Seep Areas

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Samples are to be collected in accordance with Subsection 5.3.5, Sampling of Standing Water

5.1 OVERVIEW

Surface water samples are to be collected as grab samples. Grab samples characterize a medium at a particular point in space and time. Grab water samples are collected by sample container immersion or by using a transfer device, such as a beaker or dipper as described in Subsection 5.3.2, Samples Collected by Container Immersion and Subsection 5.2.2, Sample Transfer Devices, respectively.

5.2 EQUIPMENT FOR COLLECTING SAMPLES

Equipment used for collecting surface water samples will include

- Laboratory-provided sample containers
- Sample transfer devices

5.2.1 Laboratory-Provided Sample Containers

Wherever possible, laboratory-provided sample containers will be used to collect water quality samples. Alternatively, the containers may be purchased from a supplier who certifies that bottles have been pre-cleaned to EPA specifications. Records of container certification will be kept for these containers.

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5.2.2 Sample Transfer Devices

Beakers or dippers, composed of Teflon®, stainless steel or glass, may be used if site conditions prevent sampling by sample container immersion. The selected type of transfer device, the composition of this device, and the volume of the device will be recorded in the field notes. The device is placed with the opening upstream at the midpoint of the stream flow. The sample will be poured directly from the beaker or dipper into the sample container. The sampler will attempt to minimize the disturbance of bottom materials.

5.3 PROCEDURES

Samples will be collected from the same cross-section of the stream as that used for the discharge measurement. Always collect samples prior to making discharge measurements.

5.3.1 Sample Order of Collection

The sample for total residual chlorine (TRC) will be collected and the measurement performed prior to the collection of any other samples or measurement of any other parameters. Preservation requirements for VOCs, cyanide, and BNA samples are determined by TRC concentration.

The following list represents the total variety of sample types to be collected on a monthly basis at each surface water site, and generally guides the order of collection of the samples. The Project Work Plan may require different combinations of sample types and containers.

<u>Priority</u>	<u>Analytes</u>
1	TCL, VOCs
1a	EG&G Rad Screen (when required)
2	Oil and Grease
3	Gross Alpha/Beta, U (233, 234, 235/238)

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4	TCL BNAs
5	Pesticides/PCBs
6	TAL Metals-Dissolved
7	Major Ions Cl, F, SO ₄ , Si, CO ₃ , HCO ₃ , TDS and TSS
8	TAL Metals-Total
9	Nitrate/Nitrite (as N)
10	Tritium
11	Total Radionuclides
12	Pu 239/240, Am 241
13	Sr 89/90, Cs 137, Ra (226, 228)
14	Cyanide
15	Sulfide (H ₂ S)
16	Remaining field parameters

Preferred methods of surface water sample collection are as follows

- 1 Volatile organic compounds (VOCs) will be collected as described in Subsection 5.3.2.1, Collection of Samples for Analysis of Volatile Organic Compounds
- 2 Oil and grease will be collected as described in Subsection 5.3.2.2, Collection of Samples for Oil and Grease
- 3 The remaining samples, depending on surface water flow conditions and location, will be collected as described in Subsection 5.3.2, Samples Collected by Container Immersion or Subsection 5.2.2, Sample Transfer Devices

5.3.2 Sample Collected by Container Immersion

Collection of samples will be performed as follows

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- 1 Submerge the sample bottle below the water surface with the opening pointed upstream at the midpoint of the stream flow
- 2 The sampler will attempt to minimize the disturbance of bottom materials
- 3 Allow container to fill to desired volume
- 4 Remove the container from the water
- 5 Preserve the sample, if necessary, and place the cap on the container and tighten
- 6 Decontaminate the container's outside surface
- 7 Check pH of preserved samples

5.3.2.1 Collection of Samples for Analysis of Volatile Organic Compounds (VOCs)

Samples collected for analysis of VOCs must be collected with minimal disturbance to limit aeration. The preferred method of sampling for VOCs is the collection of a grab sample directly into the sample container. The container used for the collection of VOC's is a 40-ml glass vial with a cap containing a Teflon®-coated septum. The following method will be strictly followed.

- 1 At the approximate center of the discharge stream, submerge the container just below the surface and collect a single sample. Minimize disturbance as much as possible in order to protect the integrity of the sample's volatile constituents.
- 2 Allow the vial to fill and form a meniscus at the top. Place the cap over the vial so that the Teflon®-coated side of the septum is in contact with the sample.

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- 3 **Firmly tighten the cap**
- 4 **Invert and gently tap the vial to verify that there are no entrapped air bubbles. If air bubbles are present, dispose of the sample and vial, then select another container and resample.**
- 5 **Decontaminate the outside surface of the container.**
- 6 **If conditions preclude the collection of surface water directly into the sample container, VOC samples will be collected by the use of a transfer device. The beaker or dipper should be partially submerged, filled, and retrieved with minimal disturbance and delay. After retrieval, the sample container should be tilted at a slight angle against the edge of the beaker or dipper allowing the water in the beaker or dipper to slowly empty into the container. The sample stream should flow gently down the side of the container to ensure minimal sample aeration, then handle the sample as described in Steps 2-5 listed above.**

5.3.2.2 Collection of Samples for Oil and Grease

Because oil and grease are relatively insoluble in water and tend to float on the surface of the water, samples for oil and grease analysis will be collected, whenever possible, by partial container immersion. Samples will be collected in the following manner:

- 1 **Lower the bottle into the water so that the open mouth of the bottle faces upstream.**
- 2 **Partially submerge the sample container so that the mouth of the bottle collects the sample at the water surface.**

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- 3 The bottle will not be held around the top of the open mouth, as this may result in oil and grease attaching to the holder instead of entering the bottle
- 4 Allow the container to fill to within about 1.5 inch from the top of the bottle when practical (if the bottles are not pre-preserved, allow enough remaining room for addition of the H_2SO_4 preservative) Once the sample is collected, water may not be poured off the top of the containers because this will probably result in the loss of a significant portion of any oil and grease in the sample
- 5 Remove the container from the water, add the preservative, and screw on the cap tightly
- 6 Decontaminate the container's outside surface

While this method tends to collect a worst-case oil and grease sample, it is the only method that will ensure consistent sample collection and eliminate the possibility of underestimating the oil and grease concentration. Areas where oil and grease levels are a concern may be sampled later by collection of samples at the surface and at additional depths if an estimate of average concentrations is desired.

If low flow conditions prohibit collection of oil and grease as described above, samples may be collected by partial immersion in cooperation with the low flow collection method described last in Subsection 5.3.5, Sampling Under Low Flow Conditions.

5.3.3 Sampling of Standing Water

Special considerations must be taken when sampling pools of standing water which are often found as detention storage or on saturated ground surfaces. Because there is no measurable discharge

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at these locations, the volume of water present will be measured by estimating the depth of water and the surface area covered by the water

Due to the possibility of small volumes of water in areas of standing water the priority of sampling collection discussed in Subsection 5.3.1 Sample Order of Collection will be followed. The method of collection for the sampling of an area of standing water with a small volume of water will follow guidelines set forth in Subsection 5.3.5, Sampling Under Low Flow Conditions

Only small pools, sumps, or ditches containing stagnant water that allow sampling from the approximate center of the pool will be sampled. Such a pool will generally be less than 4 feet in diameter or width and less than 1 foot deep. The procedure for the sampling of pools larger than 4 feet in diameter is covered in SOP SW 8, Pond Sampling

5.3.4 Remote Sampling

Standpipes or sumps typically contain small, relatively nonstratified volumes of standing water. In general, the volumes of these bodies of water are sufficiently small so that the action of lowering a sample container into the standing water will produce adequate mixing to eliminate any stratification which may exist.

The preferred method for sampling in standpipes or sumps is by container immersion. A stainless steel clamp or Teflon® attached to a stainless steel or aluminum extending rod will be used to hold the sample container. Only stainless steel or aluminum rods will be used for remote sampling. The material (stainless steel or aluminum) composition of the rod will be recorded on the field notes.

The container will be carefully lowered into the standing water and allowed to fill. The field crew member will not allow the extension rod or the sample container to make contact with the sides or bottom of the standpipe or sump, nor with any pumps or other structures inside the standpipe or

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sump Such contact may dislodge materials loosely attached to these surfaces and create a potential to contaminate the sample

If a sample container cannot be filled by container immersion, then a stainless steel, Teflon®, or glass beaker or dipper attached to a remote sampling extension rod will be used to obtain a dip sample. The sample will be poured directly from the beaker or dipper into the sample container. The sampling personnel will record in the field note the type of container used and the material of which the container is made.

5.3.5 Sampling Under Low Flow Conditions

Flow conditions at surface water sampling sites vary seasonally. Some of the sites may possess low discharges with depth of flow being less than 0.5 inch. The field sampling crew will attempt to obtain samples of water at these sites by use of a transfer device. The sampler will attempt to minimize the disturbance of bottom materials. NPDES sites will not be sampled when water depth is less than 0.5 inches.

Sample containers will be filled as long as it is possible to dip water from the small stream into a beaker without disturbing bed materials. If flow is so low that all sample bottles cannot be filled, collect as many samples as possible while following the order of collection described in Subsection 5.3.1 and record the site flow conditions.

Surface water sites possessing flow depth of less than 0.5 inch, and having no defined channel (i.e. seeps), are known to exist at RFP. Field crews may attempt to obtain water samples at such sites as follows:

- 1 Dig a small depression in the soil within the path of flow

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- 2 Place a stainless steel bowl in this depression, with the rim of the bowl below the water surface
- 3 Allow the bowl to become full of water, to overflow, and to continue to overflow for several minutes until sample clarity is achieved
- 4 Obtain samples from the bowl by container immersion or by the dip and transfer method

6.0 DECONTAMINATION

Procedures for decontamination are set forth in the site-specific health and safety plan and SOP FO 3, General Equipment Decontamination

7.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP

QC samples for surface water sampling fall into five categories

- Duplicate
- Matrix spike
- Matrix spike duplicate
- Equipment rinse
- Field blank

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SOP SW 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples describes the general handling of samples, including QC samples. Applicable Workplan/Quality Assurance Addenda specify QC sample frequencies.

Sample collection procedures for duplicate, matrix spike, and duplicate matrix spike samples will be the same as those described for real sample collection in Section 5.0. Duplicate samples will be collected immediately after the suite of regular analytes have been collected. These samples are to be taken in the same location as the original samples. Duplicate samples are collected and analyzed to provide an indication of overall sampling and analytical precision. Matrix spike and matrix spike duplicate samples are used to provide measures of laboratory consistency in analytical and storage procedures.

An equipment rinsate sample is intended to check for potential contamination of the sample by the sampling equipment. For the surface water sampling operation, a rinsate sample will be collected from sampling equipment before the sampling equipment is used. Approximately 3 liters of distilled water will be rinsed over a decontaminated sampler and collected in a large decontaminated stainless steel bowl. A decontaminated glass or stainless steel beaker will be used to dip the water from the bowl and fill the sample bottles. The rinsate samples will be analyzed for the same parameters as the surface water samples. Equipment rinsates provide an indication of the effectiveness of decontamination procedures.

Field blank samples are containers filled at the sampling station with distilled or deionized water that are handled and transported the same as the other samples to check for potential cross-contamination resulting from sample collection, preparation and transportation procedures.

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8.0 DOCUMENTATION

Information required by this SOP will be documented on the Surface Water Data Collection Field Notes form (SW 1A), in project logbooks or on NPDES/FFCA daily log sheets found in the NPDES/FFCA Operations Sampling Plan. See SOP SW 1, Surface Water Data Collection Activities for a copy of form SW 1A. Any information regarding sampling activities, such as sampling times, deviation from procedures, or other items for which there is no designated space on form SW 1A, should be recorded in project logbooks.

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TITLE
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Approved By

(Name of Approver)

MAY 12 1992

(Date)

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used at the Rocky Flats Plant (RFP) to measure surface water discharge in streams and ditches or from seeps and pipes. Discharge is defined as the volume rate of flow of water, including any substances suspended or dissolved in the water. This document outlines a set of standard methods for various flow conditions at RFP.

This SOP describes equipment and procedures that will be used for field data collection and documentation in order to attain acceptable standards of accuracy, precision, comparability, representativeness, and completeness.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing these procedures are required to have the appropriate health and safety training as specified in the site-specific Health and Safety Plan. Personnel obtaining surface water discharge measurements will be hydrologists, geologists, engineers or field technicians with an appropriate amount of applicable field experience or on-the-job training under the supervision of another qualified person.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

Driscoll, Fletcher G., Ph.D. Groundwater and Wells Second edition. Johnson Filtration Systems, Inc., St. Paul, Minnesota. 1986

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Linsley, Ray K. and Joseph B. Franzini. Water-Resources Engineering McGraw-Hill, Inc. 1964

Rantz, S.E et al. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge Geological Survey Water-Supply Papers 2175. U.S. Government Printing Office Washington, D C 1982

Rouse, Hunter, ed. Engineering Hydraulics. Proceedings of the Fourth Hydraulics Conference. Iowa Institute of Hydraulic Research, June 12-15, 1949 John Wiley & Sons, Inc., New York.

U.S. Environmental Protection Agency Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual Environmental Services Division, Region IV Athens, GA April 1986

U.S. Department of the Interior Hydraulic Measurement and Computation "Discharge Measurements at Gaging Stations" Book 1, Chapter 11, Geological Survey. Reston, VA 1965

U.S. Department of the Interior National Handbook of Recommended Methods for Water-Data Acquisition. Office of Water Data Coordination, Geological Survey. Reston, VA, 1977

4.2 INTERNAL REFERENCES

A related SOP cross-referenced by this SOP is

- SOP SW 1, Surface Water Data Collection Activities

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5.0 METHODS

This SOP describes Environmental Protection Agency (EPA)-approved discharge measurement methods. Methods are based on known conditions at RFP. A variety of discharge measurement methods are required because flow conditions differ from site to site. In consideration of these varied conditions, this SOP describes possible flow conditions that may be encountered and describes methods that are to be used based on the site-specific flow conditions.

Because of the dynamic nature of surface water characteristics, flow measurement by the methods described in this document may be impossible at some sites. If immeasurable flow conditions are encountered at a surface water data collection site, the field crew will attempt to measure flow at a point upstream or downstream of the site. Whether or not a measurement is made, the crew will note the conditions that inhibited accurate flow measurement at the designated site.

Selection of discharge measurement methods is based on the following existing conditions at RFP:

- Flumes to be installed at RFP are Parshall flumes
- Pipes in and around the protected area (PA) contain gravity flow (These may be difficult to reach with a velocity measuring device)
- Many stream channels are rocky and historical stream discharge measurements indicate that portable flumes failed to adequately contain flow

In view of these existing physical constraints, Table SW 4-1, Discharge Measurement Methods Based on the Type of Site, will be consulted to select the method used at a particular site.

The control structure (flume) method should be used for discharge measurements in streams or ditches when flumes are in place and operational. The volumetric method, is to be used only for measurement of discharge from pipes.

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Table SW.4-1

DISCHARGE MEASUREMENT METHODS BASED ON THE TYPE OF SITE

<u>Type of Site</u>	<u>Method</u>
Pipe	Volumetric
Flume	Flume
Flume, with aquatic vegetation	Velocity-area
Stream channel, no flume	Velocity-area
Ditch	Velocity-area
NPDES discharge locations	Flume with totalizer readings

It is recommended that the velocity-area method be used at specific sites where aquatic vegetation or other materials located in the flume or in the channel downstream from the flume may produce backwater conditions. Backwater conditions are discussed in Subsection 5.1.3.2, which describes required measurement conditions for flumes.

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5.1 BUCKET AND STOPWATCH VOLUMETRIC METHOD

The volumetric method is a simple and accurate method for measuring flow from small discharges and will be utilized at RFP to measure gravity flow discharges from pipe outlets. This method involves observing the time required to fill a container of known capacity, or the time required to partly fill a calibrated container to a known volume. Alternatively, in the case of measuring discharge remotely in a sump or standpipe setting, the volumetric method may be performed by capturing flow in a container for a set period of time no less than 10 seconds. This volume of water is then measured and discharge is determined.

5.1.1 Equipment

The "bucket and stopwatch" technique is particularly useful for the measurement of small flows. Equipment required to make this measurement is a calibrated container and a stopwatch. For measurements at RFP, calibrated containers of varying sizes will include:

- 5-gallon calibrated bucket
- 2-liter graduated cylinder
- 1-liter graduated cylinder
- 1-liter beaker
- 500-milliliter beaker
- 250-milliliter beaker

Extension rods will be used to hold a container for capturing flow in enclosed areas containing discharging pipes.

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5.1.2 Maintenance and Calibration Procedures

Graduated cylinders are incremented in terms of milliliters and can be easily converted to gallons. The incremental volume of a 5-gallon bucket can be determined by adding known volumes of water and recording the depth after each addition

5.1.3 Field Procedures

In accordance with SOP SW 1, Surface Water Data Collection Activities, the field crew will assess the type of site being visited. Upon arrival at the site, the technicians will evaluate the flow conditions to select the appropriate method for flow measurement. If the flow conditions meet those outlined in Subsection 5.1.1, then the technicians will observe and use judgement in approximating the flow volume and will select an appropriately sized volumetric container to use the volumetric method of flow measurement.

A technician will use a stopwatch to measure the time required to fill a volumetric container. The technician will time flow into the container for a minimum of 10 seconds. Three consecutive measurements will be made and noted, and the results averaged to determine the discharge.

If remote measurement is necessary, a container will be attached to an extension rod. The technician will time flow for a minimum of 10 seconds. The volume of water will then be poured into a calibrated container, measured, and recorded. Three such measurements will be made, noted, and the results averaged to determine the discharge.

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5.1.4 Discharge Calculations

Discharge will be determined initially in gallons per second (gal/s) or in milliliters per second (ml/s). These values will be noted, but the averaged value will be reported in cubic feet per second (cfs). Calculations will be performed as follows:

- Record each of the three measurements in terms of gallons per second or milliliters per second, depending on the volumetric container.
- If one of the three measurements is 50 percent or more different from the other two measurements, then this value will not be used. Instead, three additional measurements will be taken and, provided that none of these measurements differs by greater than 50 percent from the other two measurements, these values will be used.
- Average the three values.
- Convert the averaged value to cfs as follows:
 - to convert ml/s to cfs, multiply by 3.53×10^{-5}
 - to convert gal/s to cfs, multiply by 0.134
- Record discharge in cubic feet per second (cfs).

5.2 VELOCITY-AREA METHOD

The vertical axis current meter has been selected to perform velocity-area method discharge measurements. A common type of vertical axis current meter is the Price meter, type AA (see

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Figure SW 4-1). A current meter is an instrument used to measure the velocity of flowing water. The principle of operation is based on the proportionality between the velocity of the water and the resulting angular velocity of the meter rotor. By placing a current meter at a point in a stream and counting the number of revolutions of the rotor during a measured interval of time, the velocity of water at that point is determined. The number of revolutions of the rotor is obtained by an electrical circuit through the contact chamber. Contact points in the chamber are designed to complete an electrical circuit at selected frequencies of revolution. The electrical impulse produces an audible click in a headphone. The intervals during which meter revolutions are counted are timed with a stopwatch.

A Price pygmy meter will be used in shallow depths and low velocities (see Figure SW.4-1). The pygmy meter is scaled two-fifths as large as the type AA meter. The pygmy meter makes one contact (click) per revolution while the type AA meter can make one click per revolution or one click per five revolutions. The predominant flow conditions in channelized streams at RFP indicate that the pygmy meter will be used far more frequently than the Price AA meter.

5.2.1 Introduction

The current meter measures velocity at a point. The velocity-area method requires measurement of the mean velocity in selected subsections of the stream cross section. By dividing the stream width into subsections, discharge becomes the total of discharges measured in each subsection (see Figure SW 4-2). Velocity (v) is measured at each subsection, and discharge becomes the sum of the products of each point velocity and cross sectional area of each subsection.

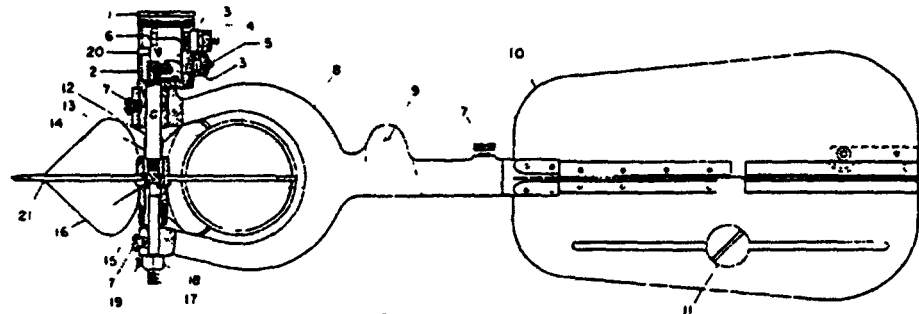
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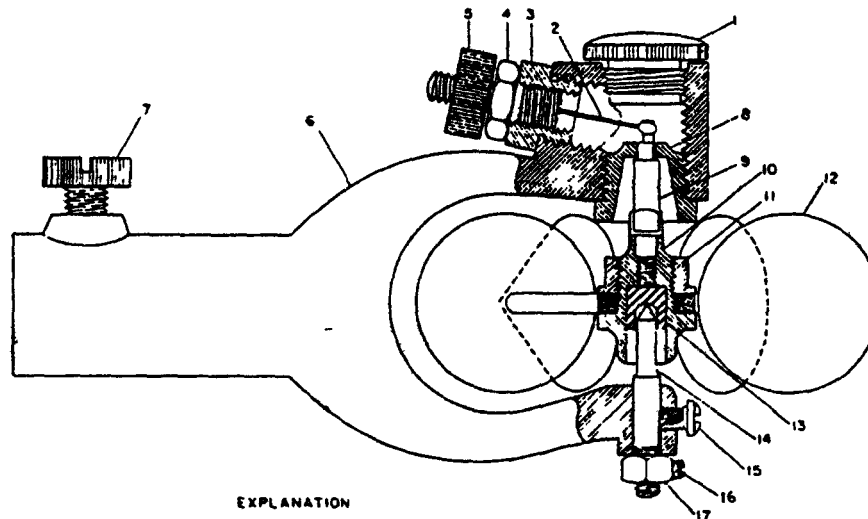
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EXPLANATION

- | | |
|---|---|
| 1 Cap for contact chamber | 11 Balance weight |
| 2 Contact chamber | 12 Shell |
| 3 Insulating bushing for contact binding post | 13 Bucket-wheel hub |
| 4 Single-contact binding post | 14 Bucket-wheel hub nut |
| 5 Penta-contact binding post | 15 Raising nut |
| 6 Penta gear | 16 Pivot bearing |
| 7 Set screw | 17 Pivot |
| 8 Yoke | 18 Pivot-adjusting nut |
| 9 Hole for hanger screw | 19 Keeper screw for pivot-adjusting nut |
| 10 Tampiece | 20 Bearing lug |
| | 21 Bucket wheel |

Assembly diagram of type-AA Price current meter



EXPLANATION

- | | |
|-----------------------------------|-------------------------------------|
| 1 Cap for contact chamber | 10 Bucket-wheel hub |
| 2 Binding-post beaded wire | 11 Bucket-wheel hub nut |
| 3 Binding-post insulating bushing | 12 Bucket wheel |
| 4 Binding-post body | 13 Pivot bearing |
| 5 Binding-post nut | 14 Pivot |
| 6 Yoke | 15 Pivot set screw |
| 7 Yoke set screw | 16 Pivot-adjusting nut |
| 8 Upper bearing | 17 Pivot-adjusting nut keeper screw |
| 9 Shell | |

Assembly diagram of pygmy current meter

SOURCE WRI BOOK 8,
CHAPTER B2

(4011-940-0140-940)

Job No 4011

Prepared by MAS

Date 03/01/92

PRICE TYPE AA METER, TOP,
PRICE PYGMY METER, BOTTOM

FIGURE SW 4-1

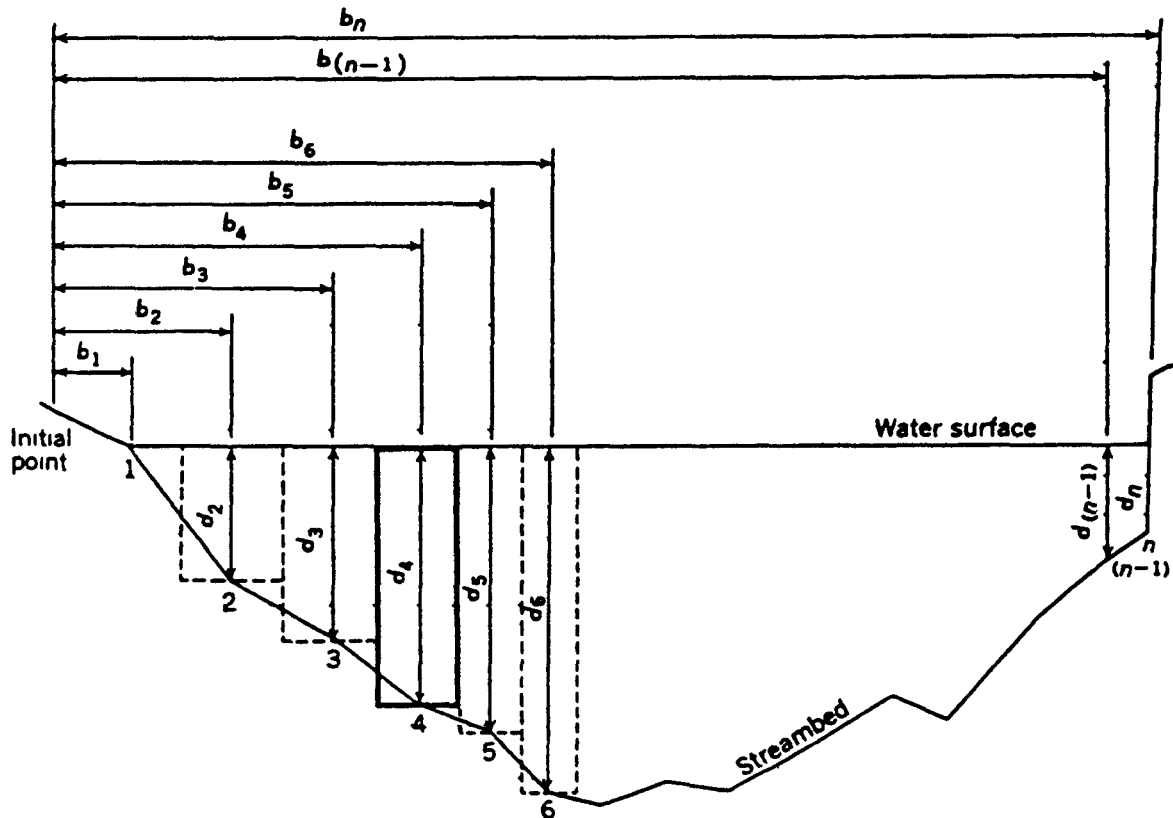
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EXPLANATION

1, 2, 3	n	Observation verticals
$b_1, b_2, b_3,$	b_n	Distance, in feet or meters, from the initial point to the observation vertical
$d_1, d_2, d_3,$	d_n	Depth of water, in feet or meters, at the observation vertical
Dashed lines		Boundaries of subsections, one heavily outlined is discussed in text

SOURCE
GEOLOGICAL SURVEY
WATER-SUPPLY
PAPER 2175, 1982

(4011-940-0141-940)

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DEFINITION SKETCH OF MIDSECTION
METHOD OF COMPUTING CROSS-SECTION
AREA FOR DISCHARGE MEASUREMENTS

FIGURE SW 4-2

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$$Q = \Sigma va$$

Where Q is total discharge, v is point velocity, and a is the area of the subsection.

In general, the hydrographer measuring discharge should strive to measure no more than 5% of the flow in any one subsection. However, for small streams this is often impossible. Therefore, the hydrographer should divide the channel cross-section into as many subsections as possible and make 2 complete discharge measurements using different sections for each. Further, subsections need not be of identical width. Velocities near banks are generally lower than velocities near the center of streams, thus these subsections may be wider than subsections near the center. Subsections will also be more closely spaced if a stream has an unusually deep portion in the cross section, or if velocities are higher than usual for the cross section. The minimum section width for the AA-meter is 40 feet and the minimum section width for the pygmy meter is 30 feet.

Typically, velocities will be measured by current meter for a 40-70 second period. It is recognized that 40 to 70 seconds is not long enough to ensure the accuracy of a single point-observation of velocity. However, because pulsations caused by turbulent and eddying effects are random and because velocity observations during a discharge measurement are made at several verticals, there is little likelihood that the pulsations will bias the total measured discharge of a stream. Longer periods of current meter observation at a point are not used because (1) it is desirable to complete a discharge measurement before the stage changes significantly and, (2) the use of longer observation periods may add significantly to the operating cost of data collection.

5.2.2 Required Measurement Conditions

In order to make a velocity-area discharge measurement, the following conditions are required:

- 1 The stream must be channelized, that is, banks must channel the stream flow

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2. Depth must be greater than 0.2 foot across most of the cross section being measured.

The ideal channel cross section is trapezoidal in shape, completely smooth in boundary materials, and possesses a uniform velocity distribution. It is recognized that no such cross sectional areas exist at RFP. Therefore, minor modifications to the stream channels will be used in order to optimize measurement conditions. These modifications may include removal of aquatic vegetation, ice, and moving small stones which impact velocity upstream or downstream of the cross section.

Current meter measurements will be made by wading, if conditions permit. The type AA or pygmy meter is used for wading measurements. Table SW 4-2 lists the type of meter and velocity method to be used for wading measurements at various depths. The hydrographer should stand at arm's length to the side of the meter.

TABLE SW.4-2
VELOCITY MEASURING POINT SELECTION

Stream Depth (ft)	Type of Meter	Velocity Measuring Point(s) (% of Depth)
2.5 or more	Type AA	0.2 and 0.8
1.5 - 2.5	Optional	0.6
0.3 - 1.5	Optional	0.6
<0.3	Pygmy	0.5

Some departure from Table SW 4-2 will be permitted. If the stream velocity is high it may not be possible to count clicks with a pygmy meter. If this occurs the type AA meter should be used. Do not switch from one meter to another in the middle of a discharge measurement.

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Under open channel laminar flow conditions, the effect of fluid contact with the bed of a stream channel and the air is a vertical distribution of velocities. Consistent with this velocity distribution, actual observation and mathematical theory has demonstrated that a single measurement of velocity taken at 0.6-depth or the average of two point velocities taken at 0.2 and 0.8 of the depth below the surface accurately results in mean velocity in the vertical (U.S.G.S Water-Supply Paper 2175,133-134pp)

If the stream is generally less than 2.5 feet deep, use the six-tenths (0.6) method. If the stream is generally greater than 2.5 feet, the two-and-eight-tenths (0.2 and 0.8) method, also known as the two-point method, will be used. A complete discussion concerning how to set the wading rod to place the current meter at proper depths is contained in Subsection 5.1.2.5

In the 0.6-depth method, an observation of velocity made in the vertical at 0.6 of the depth below the surface is used as the mean velocity in the vertical. In the two-point method of measuring velocities, observations are made in each vertical at 0.2 and 0.8 of the depth below the surface. The average of the two observations is taken as the mean velocity in the vertical.

A depth of 1.25 feet will accommodate the 0.6-depth method without causing the meter to be set closer than 0.5 feet from the streambed, if the meter is set any closer to the streambed, it will under-register the velocity. If the technician is at a measurement section that has only a few verticals shallower than 1.25 feet, the technician should use the type AA meter rather than the pygmy meter if the depth is no less than 0.5 feet at any vertical.

Vertical axis current meters do not register velocities accurately when placed close to a vertical wall. A Price meter held close to a right-bank vertical wall will under-register because the slower water velocity near the wall strikes the effective (concave) face of the cups. The converse is true at a left-bank vertical wall. (The terms "left bank" and "right bank" designate direction from the center of

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a stream for an observer facing downstream) The Price meter also under-registers when positioned close to the water surface or close to the streambed

5.2.3 Equipment

Current meters, timers, depth and width measuring devices, and a means of counting meter revolutions are needed for measurement of discharge. The equipment includes.

- Top-setting wading rod and Current meter
- Width-measuring devices, either engineer's tape or tagline
- Digital counter or headset and stopwatch
- Current meter rating tables
- Stakes for width-measuring devices
- Calculator

5.2.3.1 Top-setting Wading Rod The depth-measuring device that will be used is the wading rod. The current meter is attached to the wading rod. The top-setting rod is preferred for use at RFP because of the convenience in setting the meter at the proper depth and because the hydrographer's hands remain dry in the process. The top-setting wading rod has a 1/2-inch hexagonal main rod for measuring depth and a 3/8-inch diameter round rod for setting the position of the current meter.

5.2.3.2 Current Meter. See description in Subsection 5.1.2.

5.2.3.3 Engineer's Tape or Tagline. Tape measures or premarked taglines are used for stream width measurements. Orientation normal to the flow pattern of the stream and elimination of most of the sag, through support or tension, are recommended for improved accuracy.

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5.2.3.4 Digital Revolution Counter or Headset. The digital revolution counter attaches to an electronic connection at the top of the wading rod. The digital display shows the number of seconds of elapsed time. The hydrographer stops the counter after 40 or more seconds, and the counter automatically displays the velocity.

If the digital counters are unavailable, the headset will be used as a means for determining the number of revolutions. A headset attaches to an electronic connection at the upper end of the wading rod. The hydrographer wears this headset to listen to the audible clicking sounds produced by current meter revolutions. The number of rotations are counted and timed. Velocities as a function of time are listed on a current meter rating chart, which is kept in the current-meter carrying case.

5.2.3.5 Stopwatch. A stopwatch is used to measure time during which velocity is measured at each point in the cross section.

5.2.4 Maintenance and Calibration Procedures

Prior to and following the use of the current meter, spin tests will be conducted to ensure that the unit performs acceptably. The spin test will be performed in an enclosed area, such as in the cab or in the enclosed rear of a truck, to prevent wind interference. The test is to be performed prior to attaching the current meter to the wading rod. While holding the meter steady in an area sheltered from breezes, the technicians will spin the rotor and then press the start button on the stopwatch. The technician will observe the meter until the rotor ceases to spin.

The duration of the spin for the pygmy meter will be more than 40 seconds, and for the Price AA meter, it will be more than 90 seconds. If the meter fails to meet the time-of-spin criteria, the meter will be cleaned and oiled before use. If the meter continues to spin well beyond these time

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limits, the record will indicate that the meter spun for 40+ seconds, in the case of the pygmy meter, or for 90+ seconds in the case of the Price AA meter.

To ensure reliable observations of velocity, it is necessary that the current meter be kept in good condition. Before and after each discharge measurement, the meter cups or vanes, pivot and bearing, and shaft will be examined for damage, wear, or faulty alignment. During measurements, the meter will be observed periodically when it is out of the water to be sure that the rotor spins freely.

Meters will be cleaned and oiled daily when in use. If measurements are made in sediment-laden water, the meter will be cleaned immediately after each measurement. After oiling, wipe away any excess oil and spin the rotor to make sure that it operates freely. If the rotor stops abruptly, the cause of the trouble will be sought and corrected before using the meter.

In addition to meter maintenance, the entire unit consisting of current meter, wading rod, and digital counter or headset will be checked before departure to the field each day as follows:

- Attach the current meter and digital counter/headset to the wading rod.
- Check the digital counter by ensuring that the readout is visible when the unit is turned on.
- If a headset is being used.
 - Spin the current meter to ensure that audible clicks occur.

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- If audible clicks do not occur, the following steps should be taken
- Check that electronic connections are tight.
- Check that the cat's whisker lightly contacts the upper part of the shaft
- Spin again If audible clicks still do not occur, check that the battery in the headset is properly aligned. Replace the battery, if necessary

5.2.5 Field Procedures

5.2.5.1 Overview. In accordance with SW 1, Surface Water Data Collection Activities, the field crew will determine the type of site being visited. Upon arrival at the site, the field technicians will evaluate the flow conditions to determine which measurement method is appropriate. Based on flow conditions, either the Price AA meter or the pygmy meter will be selected to perform a velocity-area measurement.

At each measurement point (or section) across the stream cross section, depth is measured prior to measurement of velocity. Place the wading rod about 0.5 feet downstream from the tagline to prevent contact with the current meter when the meter is lowered into measuring position. Place the wading rod in the stream so the base plate rests on the streambed. The depth of water is read from the graduated main rod. The main rod is graduated into 0.1-foot increments. These increments are indicated by a single score in the metal. Half-foot increments are marked by two scores in the metal, and each foot is marked by three scores in the metal. A vernier scale on the upper handle of the rod corresponds to 0.1-foot increments, and has 1 through 9 in raised numbers.

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next to raised marks. A sliding, adjustable rod, known as the setting rod, to which the meter is attached, has single scored marks which are aligned with values on the vernier scale.

In high velocity areas, it is recommended that depth be read as the value between depth on the upstream side of the rod and depth on the downstream side of the rod. Depth is measured to the nearest 0.02 foot. This depth is used to set the vertical location of the current meter.

The setting rod is then adjusted downward so that the scored mark of the setting rod which corresponds to the range of depth in feet (e.g., if depth = 0.46, range in feet = 0, or if depth = 1.72, range in feet = 1) is aligned with the stream depth value transposed to the vernier scale. This automatically positions the meter for use in the 0.6 method as the meter is then six-tenths of the total depth from the surface of the water.

For using the two-point method of velocity measurement, the depth of water is divided by 2. This value is set so that the meter will be at the 0.8-depth position from the water surface. The depth of water is then multiplied by 2, and this value is set. The meter will then be at the 0.2-depth position measured down from the water surface. These two positions represent the conventional 0.2- and 0.8-depth positions. If depths are less than 0.30 foot, the 0.5 method may be used. The observation depth recorded will then be 0.5 of the total depth.

5.2.5.2 Steps to be Followed in Measuring Discharge. If water quality or sediments are sampled in conjunction with discharge measurement, samples will be collected prior to making discharge measurements. The following steps are to be followed in discharge measurement:

- Evaluate the measurement location. Choose a location where flow is least turbulent. If the prescribed location is in a stream reach with highly turbulent flow conditions, try to select a location immediately upstream or downstream from the prescribed location. Flow should be visible from bank to bank. Eddies and slack

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water must not be present. Neither the type AA meter nor the pygmy meter will be used for measuring velocities slower than 0.1 fps unless absolutely necessary.

- Remove aquatic vegetation, ice, or other minor flow impediments. When such modifications are made, exercise great care to avoid unnecessary movement of sediments or the splashing of sediments or water onto field personnel. Allow flow to stabilize before the current meter measurement begins.
- Position a tape about 1 foot above the surface of the water. Secure the tape so that it remains taut and perpendicular to the channel.
- Select a starting point at either the left bank (left edge of water, LEW) or the right bank (right edge of water, REW). LEW and REW are determined when facing downstream. Record LEW and REW in the manner shown in Figure SW 4-3 on the Discharge Measurement Notes (Figure SW 4-4).
- Note the distance in feet, and the stream direction, that this cross section lies from the prescribed location. For example, the note may read "25 feet downstream" or "15 feet upstream."
- Measure the width of the stream, in feet. After selecting the Price AA or pygmy meter (see Table SW 4-2), follow guidelines in Subsection 5.1.2.1 to select the number of subsections in which to measure velocity attempting to measure no more than 5% of total flow in any one section, if possible.
- After determining the distance desired between measuring points, commonly referred to as sections, measurement can begin. Record the time and bank at

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DISCHARGE MEASUREMENT NOTES

Party GCA MAS Comp. By MAS Checked By GCA
Width: 2.0 ft Area: 0.698 ft² Gauge Height:
Method: Type of Meter pygmy Spin. Before 40+ After 40+
Comments/observations:

Cross Section

Flow

Other

	DIST FROM INIT POINT	WIDTH (FT)	DEPTH (FT)	OBSER DEPTH	REVS	TIME (SEC)	VELOCITY (F/S)		AREA (FT ²)	DIS-CHARGE (CFS)
							AT POINT	MEAN IN VERTICAL		
LEW	5.0	0.1	φ		—	—			φ	
	4.8	0.3	0.2		15	43	0.369		0.06	0.022
	4.4	0.4	0.38		3	70	0.07		0.152	0.011
	4.0	0.4	0.32		φ	—	—		0.128	—
	3.6	0.4	0.36		10	44	0.25		0.144	0.036
	3.2	0.4	0.36		7	52	0.16		0.144	0.023
REW	2.8	0.35	0.20		φ	—	—		0.07	—
	2.5	0.15	φ		—	—	—		φ	—
									0.698	0.092 cfs

Site ID

SW005

Date

5/1/90

Signature

M. J. H.

Total Discharge

Job No 4011

Prepared by MAS

Date 03/01/92

COMPUTATION NOTES OF A
CURRENT-METER MEASUREMENT

FIGURE SW 4-3

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Date	Time	Depth	Width	Flow	River at—			Discharge
					At point	VELOCITY		
						Time in sec	Mean in sec	
6								66
10								70
20								74
30								78
40								82
50								86
60								90
70								94
80								98
90								102
100								106
110								110
120								114
130								118
140								122
150								126
160								130
170								134
180								138
190								142
200								146
210								150
220								154
230								158
240								162
250								166
260								170
270								174
280								178
290								182
300								186
310								190
320								194
330								198
340								202
350								206
360								210
370								214
380								218
390								222
400								226
410								230
420								234
430								238
440								242
450								246
460								250
470								254
480								258
490								262
500								266
510								270
520								274
530								278
540								282
550								286
560								290
570								294
580								298
590								302
600								306
610								310
620								314
630								318
640								322
650								326
660								330
670								334
680								338
690								342
700								346
710								350
720								354
730								358
740								362
750								366
760								370
770								374
780								378
790								382
800								386

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Measure No.

Complete by

Checked by

Date	Width . . .	Area	Party		C H	Duct	Snap	Meter No.
	Method	No. sec	G change	in				
	Method and		Hr angle and					

GAGE READINGS			Type of meter
Time	Ready	Inside	Date read
			Meter
			Spn before meas.
			Mass piece
			Winding cable wt. boat upst., downst., side
			bridge
			gate and
			Check-bar found
			changed to
			Correct
			Leads obtained

Measurement rated excellent (7%), good (5%), fair (6%), poor (over 8%), based on following conditions: Cross section, Weather

[illegible][illegible][illegible]

2. 11. of zero flow

SOURCE
GEOLOGICAL SURVEY
WATER-SUPPLY
PAPER 2175, 1982
(4011-940-0143-940)

Job No 4011
Prepared by MAS
Date 03/01/92

DISCHARGE MEASUREMENT NOTES

FIGURE SW.4-4

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which measurement starts on the discharge measurement notes as "REW Start 0000", using REW or LEW depending upon whether starting at the right or the left edge of the water

- Note the distance to the beginning edge of water from the initial point. The initial point is an arbitrary point on the tape, preferably zero, which lies on the shoreline of the stream. All station locations are recorded as distances from the initial point.
- Proceed to the first station beyond the edge of water. Record the distance from the initial point on the discharge measurement notes. Place the wading rod into the stream so the base plate rests on the stream bed.
- Stand downstream of the tagline or tape and face upstream. Do not stand behind or close to the meter. Raise the current meter on the wading rod so that it is well above the surface of the water.
- Measure stream depth at the measurement point as indicated on the wading rod. Record the stream depth to the nearest 0.02 foot (for example 0.32 feet or 1.54 feet).
- Lower the meter to the required depth and record the observation depth. The observation depth as a fraction of total depth is 0.6, 0.2, 0.8 or occasionally 0.5.
- The technician will stand in a position that least affects the velocity of the water passing the current meter. That position is usually obtained by facing upstream with the arm fully extended. The technician will stand at about a 45-degree angle downstream from the wading rod. The wading rod is held in a vertical position.

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with the meter parallel to the direction of flow. Avoid standing in the water when possible.

- Start the digital counter. After 40 seconds, stop the counter. Note that the counter reports velocity.
- If using the headset rather than the digital counter, start the stopwatch on the first click and begin counting clicks. The first click counted after starting the stopwatch is counted as one.
- After at least 40 seconds have passed, stop the stopwatch on a click. Record the number of seconds and the number of revolutions (clicks) on the same line of the notes as the recorded depth.
- Determine velocity as a function of elapsed time and number of revolutions from the velocity chart. Record velocity in the appropriate column. If the flow meter is not lined up parallel to the flow, the cosine of the angle that the flow direction is from parallel is needed to correct velocity values. This is done by the following:
 - Hold up a copy of the discharge notes.
 - Line up the dot (shown in the cosine of the angle column of the notes) with the number on the tape that designates the measurement point of the cross-section.
 - Rotate the note by pivoting at the dot until the edge of the note is aligned with the flow. Find the number along the notes perimeter that lines up with the tape. This is the cosine of the angle. Record this value for the station.

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- Proceed to the next station. Record the distance from the initial point to the station. Repeat measurements of depth and velocity. Continue in this manner across the stream.
- After recording the distance measurement at the last station, record the time at which the ending edge of water is reached (e.g. LEW [or REW] FINISH 1330).
- Note velocity and depth at the edge of water as zero.
- Evaluate and record the following: Flow characteristics, weather conditions, air temperature, water temperature, observer(s), type of meter, and remarks.
- If less than 20 subsections have been used for the measurement, repeat the measurement steps. Begin from the opposite bank from where the previous measurement began.

5.2.6 Discharge Calculations

Using a calculator as needed, calculate discharge on the discharge notes as follows.

- Use the distances from initial point to compute width for each subsection. The first width is computed by subtracting the first distance (edge of water) from the second distance, and dividing this quantity by two. The second width will be the difference between the third distance and the first distance, divided by two. For each subsequent width, subtract the previous station distance from the following station distance, and divide this quantity by two. The final width is calculated as the difference between the final distance and the second-to-the-last distance,

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divided by two Sum the width column and check to be sure that the calculated width equals the distance between the REW and LEW.

- Multiply the width by the depth for each station to determine the area of each subsection Sum the areas to determine total area.
- If the angle between the flow and the meter orientation is not 90 degrees, correct the measured velocity readings by multiplying the velocity by the cosine of the angle
- Multiply the velocity by the area for each station to obtain the discharge for each subsection
- Sum the discharges for each subsection to determine total discharge and record the value
- If two sets of discharge measurements beginning at opposite banks were taken, repeat the discharge calculations for the second set of data. Average the total discharges for the two measurements Record the average value and report it for input into the database

5.3 CONTROL STRUCTURES

Control structures such as weirs and flumes can be used to determine discharge These structures have regular dimensions that allow for a consistent relationship between water level and discharge Five Parshall flumes are in operational condition at RFP, and more are to be installed. This section describes use of Parshall flumes to measure discharge With the exception of small v-notch weirs in pipes in and near the sewage treatment plant, no weirs are known to be in operation at RFP,

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therefore, this section provides general guidelines for the use of weirs in measuring discharges. Should weirs be installed at RFP, addenda to this SOP will be prepared to describe the use of the specific type of weir in discharge measurement.

5.3.1 Introduction

5.3.1.1 Weirs. Weirs are classified under the general categories of (1) broad crested, or (2) sharp crested.

Discharge over a broad-crested weir takes the form:

$$Q = CLH^{3/2},$$

where Q is the discharge, L is the crest length, and H is the depth of water over the crest of the weir. Values for the coefficient C are given in hydraulic handbooks. While the exponent for H listed here is applicable to many weirs, hydraulic handbooks should be consulted to find the correct exponent for the weir being used.

Sharp crested weirs are constructed in a variety of shapes, but the most common are V-notch, rectangular, and Cipolletti.

5.3.1.2 Flumes. A calibrated constriction placed in a stream channel changes the level of the water in or near the constriction. Flumes are constructed so that a restriction in the channel causes the water to accelerate, producing a corresponding change (drop) in the water level.

When the physical dimensions of the flume constriction are known, discharge through the constriction may be determined from measurement of depth. Refer to Subsection 5.1.3.6.2 for a description of discharge measurement for Parshall flumes.

Typical flumes consist of three sections:

- A converging section to accelerate the approaching flow.

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- A throat section, whose width is used to designate flume size.
- A diverging section, designed to ensure that the level downstream is lower than the level in the converging section

The stage of a stream is the height of the water surface above an established elevation. Stage is usually expressed in feet. The Parshall flume consists of a converging section with a level floor, a throat section with a downward sloping floor, and a diverging section with an upward sloping floor (see Figure SW 4-5). The principal feature of the Parshall flume (developed by R. Parshall in 1922) is an approach reach having converging sidewalls and a level floor, the downstream end of which is a critical depth cross section. The primary stage measurement is made in the approach reach at some standard distance upstream from the critical-depth cross section.

The flumes are designated by the width (w) of the throat. Flumes having throat widths from 3 inches (in) to 8 feet (ft) have a rounded entrance whose floor slope is 25 percent. Smaller and larger flumes do not have that feature.

5.3.2 Required Measurement Conditions

5.3.2.1 Weirs For weir formulas to give accurate values of discharge, the upstream face of the weir must be vertical and at right angles to the channel, and the crest of the weir must be horizontal. In addition, atmospheric pressure should be maintained under the nappe, and the approach channel should be straight and unobstructed. The head, h , should be measured far enough upstream from the weir to avoid the affect of curvature of the water surface near the weir.

5.3.2.2 Flumes Ideally, flow rate through a flume may be determined by measurements at a single point some distance downstream from the inlet and above the throat.

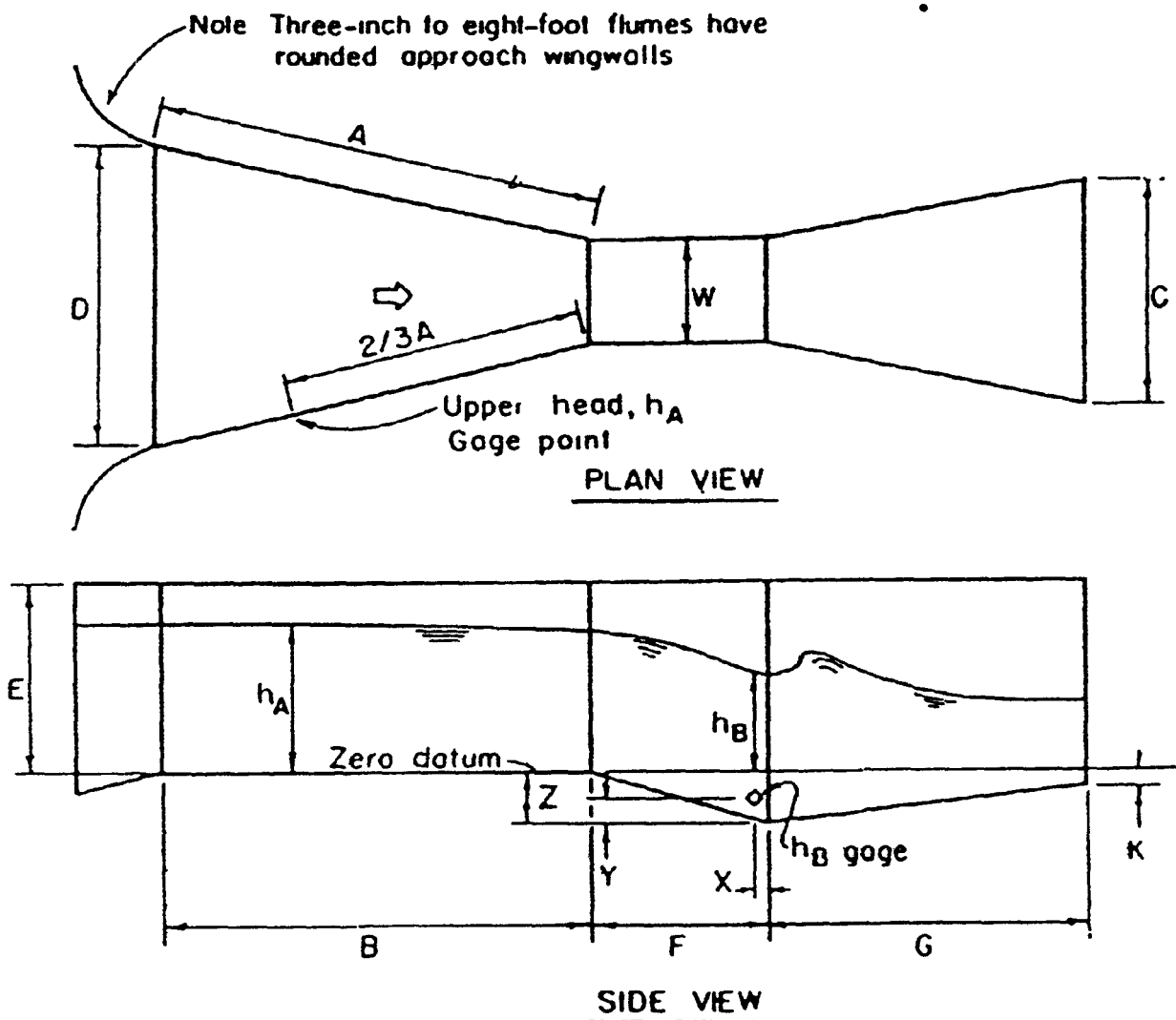
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FROM. U.S.E.P.A. ENGINEERING SUPPORT BRANCH STANDARD OPERATING
PROCEDURES AND QUALITY ASSURANCE MANUAL

Job No 4011

Prepared by MAS

Date 03/01/92

CONFIGURATION AND DESCRIPTIVE
NOMENCLATURE FOR PARSHALL FLUMES

FIGURE SW.4-5

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5.3.3 Equipment

The following equipment will be needed.

- Current meter
- Carpenter's level
- Framing square
- Measuring tapes
- Staff gauge

5.3.4 Maintenance and Calibration Procedures

5.3.4.1 Weirs. All weirs will be inspected to determine that they provide a uniform influent flow distribution and that they are placed squarely across the channel. Corrosion of the crest of a sharp-edged weir or damage by floating debris may alter the weir coefficient. If a broad-crested weir is to be used for measurement purposes, its shape must conform to one for which coefficients have been established by testing. The equations and tables found in hydraulics references that are used to compute the flow over weirs apply only to free-flow conditions. When the water level downstream from a weir rises above the level of the weir crest, the weir crest is said to be submerged. Formulas have been developed for flow over submerged weirs, but under such conditions accurate flow measurement is not possible because surface disturbances downstream from the weir make it difficult to measure the depth of submergence.

5.3.4.2 Flumes. All flumes will be inspected to determine that entrance conditions provide a uniform influent flow distribution, the converging throat section is level, and that the throat section walls are vertical. The flume will be closely examined to determine that it is discharging freely. Any problems observed during the inspection will be noted and reported to the field manager.

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5.3.5 Procedures

5.3.5.1 Overview. In accordance with SW 1, Surface Water Data Collection Activities, the field crew will determine possible flow conditions based on past activities at the site before going to the field data site. Upon arrival at the site, the technicians will evaluate the flow conditions to verify the appropriate method for flow measurement. If the flow conditions meet those outlined in Subsection 5.1.3.2, then the technicians will observe and use judgment in approximating the flow volume and will perform a measurement based on use of the control structure.

5.3.5.2 Steps to be Followed in Measuring Discharge

- Remove any material that may have accumulated in the flume or on the weir
- If the station includes a chart recorder, inspect the strip chart on the recorder to verify that it is operating
- Note any deterioration of the station, report these conditions to the field manager at the conclusion of daily data collection activities
- Measure and record the throat width to the nearest 1/10 of an inch.
- Use the staff gage to measure and record the gage height to the nearest 0.02 foot
- Calculate discharge as described in Subsection 5.1.3.6
- Record the calculated discharge and the time and date of the site visit.

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5.3.6 Discharge Calculations

5.3.6.1 Weirs. Equations are derived for weirs of specific geometry which relate static head to discharge. Weirs are generally classified into two general categories. (1) broad crested, and (2) sharp crested.

A set of weir tables is necessary for calculating flows. The weir tables are specific to the type of weir. If weirs are established at RFP, tables specific to the weirs will become an addendum to this SOP.

5.3.6.2 Flumes. A set of flume tables is necessary for calculating flows. The flume tables are specific to the type of flume. If flumes other than Parshall flumes are installed at RFP, tables specific to the flumes will become an addendum to this SOP. For Parshall Flumes refer to Table SW 4-3, Free-Flow Discharge-Parshall Flume, cfs. Based on the gage height (head, H, in feet) and the throat width of the flume (size of flume, W), the discharge is read directly from Table SW 4-3.

Note that approximate values of discharge for heads other than those shown may be found by direct interpolation in the table.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance (QA) and quality control (QC) activities will be accomplished according to applicable project plans as well as quality requirements in this SOP.

7.0 DOCUMENTATION

Information required by this SOP will be documented on the discharge measurement notes shown in Figure SW 4-4. These notes can be found in the Surface Water Data Collection Form (Form SW 1A). The form is found in SW 1, Surface Water Data Collection Activities. Data required by

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this SOP includes flow measurement device calibration information and field flow measurement data

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Table SW.4-3

Free Flow Discharge -- Parshall Flume, cfs

Head, H, Feet	Size of Flume, ft											
	3"	6"	9"	12"	15"	18"	24"	30"	36"	48"	72"	96"
0.1	0.028	0.05	0.09	—	—	—	—	—	—	—	—	—
0.2	0.082	0.16	0.26	0.35	0.51	0.66	0.97	1.26	—	—	—	—
0.3	0.154	0.31	0.49	0.64	0.94	1.24	1.82	2.39	2.96	3.52	4.08	4.62
0.4	0.241	0.48	0.76	0.99	1.47	1.93	2.86	3.77	4.68	5.57	6.46	7.34
0.5	0.339	0.69	1.06	1.39	2.06	2.73	4.05	5.36	6.66	7.94	9.23	10.51
0.6	0.450	0.92	1.40	1.84	2.73	3.62	5.39	7.15	8.89	10.63	12.36	14.08
0.7	0.571	1.17	1.78	2.33	3.46	4.60	6.86	9.11	11.36	13.59	15.82	18.04
0.8	0.702	1.45	2.18	2.85	4.26	5.66	8.46	11.25	14.04	16.81	19.59	22.36
0.9	0.843	1.74	2.61	3.41	5.10	6.80	10.17	13.55	16.92	20.29	23.66	27.02
1.0	0.992	2.06	3.07	4.00	6.00	8.00	12.00	16.00	20.00	24.00	28.00	32.00
1.1	—	2.40	3.55	4.62	6.95	9.27	13.93	18.60	23.26	27.94	32.62	37.30
1.2	—	2.75	4.06	5.28	7.94	10.61	15.96	21.33	26.71	32.10	37.50	42.89
1.3	—	—	4.59	5.96	8.99	12.01	18.10	24.21	30.33	36.47	42.62	48.78
1.4	—	—	5.14	6.68	10.10	13.48	20.32	27.21	34.11	41.05	47.99	54.95
1.5	—	—	—	7.41	11.20	15.00	22.64	30.34	38.06	45.82	53.59	61.40
1.6	—	—	—	8.18	12.40	16.58	25.05	33.59	42.17	50.79	59.42	68.10
1.7	—	—	—	8.97	13.60	18.21	27.55	36.96	46.43	55.95	65.48	75.08
1.8	—	—	—	9.79	14.80	19.90	30.13	40.45	50.83	61.29	71.75	82.29
1.9	—	—	—	10.62	16.10	21.63	32.79	44.05	55.39	66.81	78.24	89.76
2.0	—	—	—	11.49	17.40	23.43	35.53	47.77	60.08	72.50	84.94	97.48
2.1	—	—	—	12.37	18.80	25.27	38.35	51.59	64.92	78.37	91.84	105.40
2.2	—	—	—	13.28	20.20	27.15	41.25	55.52	69.90	84.41	98.94	113.60
2.3	—	—	—	14.21	21.60	29.09	44.22	59.56	75.01	90.61	106.20	122.00
2.4	—	—	—	15.16	23.00	31.09	47.27	63.69	80.25	96.97	113.70	130.70
2.5	—	—	—	16.13	24.60	33.11	50.39	67.93	85.62	103.50	121.40	139.50

NOTE Approximate values of flow for heads other than those shown may be found by direct interpolation in the table

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TITLE
SEDIMENT SAMPLING

Approved By: *[Signature]* **MAY 12 1992**
 (Name of Approver) (Date)

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2.0 PURPOSE AND SCOPE

This SOP describes procedures that will be used at the Rocky Flats Plant (RFP) to collect bed material samples from streams, ditches, ponds, and samples of water deposited materials in dry areas that meet acceptable standards of accuracy, precision, comparability, representativeness, and completeness

The methods defined in this SOP are inappropriate for sediment collection when water levels approach or overtop stream banks. The methods contained herein assume that field personnel can safely wade a stream, sample from the shore of a stream, sample from the shore of a pond, or maneuver a small boat in a pond. During sediment sampling operations, the proper personal protective equipment (PPE) will be worn, as described in the Health and Safety Plan (HSP).

3.0 RESPONSIBILITIES AND QUALIFICATIONS

Personnel sampling sediments will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual EPA.
Region IV Environmental Services Division April 1986

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Environment, Safety and Health Directive DOE Order 5400 1 November 1988

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. U S Environmental Protection Agency October 1988

Guy, Harold P Techniques of Water-Resources Investigations of the United States Geological Survey Book 3 Applications of Hydraulics, Chapter C1, "Fluvial Sediment Concepts" U.S Government Printing Office, Washington, D C. 1978

Guy, Harold P and Vernon W Norman Techniques of Water-Resources Investigations of the United States Geological Survey Book 3 Applications of Hydraulics, Chapter C2, "Field Methods for Measurement of Fluvial Sediment" U.S Government Printing Office, Washington, D C 1976

National Handbook of Recommended Methods for Water-Data Acquisition U.S Department of the Interior Office of Water Data Coordination Geological Survey 1977

Techniques of Water-Resources Investigations of the United States Geological Survey Book 5 Laboratory Analysis, Chapter C1, "Laboratory Theory and Methods for Sediment Analysis" U.S Government Printing Office, Washington, D C 1973

The Environmental Survey Manual. DOE/EH-0053 Appendices E, F, G, H, I, J, and K. U.S Department of Energy Office of Environmental Audit Washington D C. August 1987

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows

- SOP FO.3, General Equipment Decontamination

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- SOP FO 6, Handling of Personal Protective Equipment
- SOP FO.7, Handling of Decontamination Water and Wash Water
- SOP FO 9, Handling of Residual Samples
- SOP FO 10, Receiving, Labeling, and Handling Environmental Materials Containers
- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP SW 1, Surface Water Data Collection Activities

5.0 METHODS

5.1 INTRODUCTION

The sampling methods described in this SOP are used to collect bed material samples for the chemical analysis of contaminants which may be contained within the upper layers of the streambeds or adsorbed onto the surface of streambed materials on the Rocky Flats Plant (RFP) property. The uppermost sediments in ponds may also be collected by methods discussed in this SOP for similar chemical analyses

Sediments range in size from cobbles and boulders to fine silt. Table SW 6-1 shows a list of the common scale of particle sizes for sediments and serves as a reference for field personnel to understand the terms used in describing sediments in this SOP

The field technicians will evaluate the site based on conditions and particle sizes and will record site conditions and particle sizes in the field logbook or on the Sediment Sample Collection Form included in this document. This will be performed prior to sample collection. (see Table SW 6-1)

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TABLE SW.6-1
RECOMMENDED SCALE OF SIZES BY CLASSES FOR SEDIMENT ANALYSIS

Class Name	Metric Units		English Units (feet)
	(millimeters)	(micrometers)	
Boulders	> 256 0		> 0.840
Large cobbles	256 0 - 128 0		0.840 - 0.420
Small cobbles	128 0 - 64 0		0.420 - 0.210
Very coarse gravel	64 0 - 32.0		0.210 - 0.105
Coarse gravel	32.0 - 16 0		0.105 - 0.0525
Medium gravel	16 0 - 8 0		0.0525 - 0.0262
Fine gravel	8 0 - 4 0		0.0262 - 0.0131
Very fine gravel	4 0 - 2.0		0.0131 - 0.00656
Very coarse sand	2.0 - 1 0	2000 0 - 1000 0	0.00656 - 0.00328
Coarse sand	1 0 - 0.50	1000 0 - 500 0	0.00328 - 0.00164
Medium sand	0.5 - 0.25	500 0 - 250 0	0.00164 - 0.000820
Fine sand	0.25 - 0.125	250 0 - 125 0	0.000820 - 0.000410
Very fine sand	0.125 - 0.062	125 0 - 62.0	0.000410 - 0.000205
Coarse silt	0.062 - 0.031	62.0 - 31 0	0.000205 - 0.000103
Medium silt	0.031 - 0.016	31 0 - 16.0	0.000103 - 0.0000512
Fine silt	0.016 - 0.008	16 0 - 8 0	0.0000512 - 0.0000256
Very fine silt	0.008 - 0.004	8 0 - 4 0	0.0000256 - 0.0000128
Coarse clay	0.004 - 0.0020	4 0 - 2.0	
Medium clay	0.0020 - 0.0010	2.0 - 1 0	
Fine clay	0.0010 - 0.0005	1 0 - 0.5	
Very fine clay	0.0005 - 0.00024	0.5 - 0.24	

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5.2 EQUIPMENT

The following equipment items may be used for bed material sampling operations

- Decontamination equipment
- Boat
- Dredge, core sampler, or sludge sampler
- Sampler core tubes composed of stainless steel, Teflon®, or other chemically inert material
- Sample core liner caps
- Stainless steel, Teflon®-coated or glass scoop or spoon
- Teflon® tape
- Extension rods and connecting clamps
- Mixing pan
- Sieve
- Sample containers
- Sample transportation coolers

5.3 CRITERIA FOR SELECTION OF SAMPLING METHODS AND EQUIPMENT

The selection of sediment sampling devices and methods for their use are dependent on the objectives of the sampling study and other factors. Bed materials are being collected for the purpose of determining the presence, concentrations, and distribution of contaminants associated with these materials at the RFP. Composite samples will be collected to meet these objectives. In addition, information regarding the highest expected concentrations of some contaminants, specifically volatile organic compounds (VOCs), is desired.

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The physical characteristics of the sediment site to be sampled are important factors in the selection of sampling devices and methods. These characteristics include

- Grain size of bed materials
- Presence of water
- Type of water body
- Presence of organic material, rocks, or debris
- Accessibility to sampling location

Silts and clays generally possess the highest concentrations of contaminants. Therefore, areas of the finest grained sediments will be visually identified and used for the collection of VOCs. A core or sludge sampler will be used for VOC collection when water is present to help prevent disturbance of the samples. Check valves in these devices prevent washout during recovery. When collecting VOCs in dry sediments, an attempt should be made to use a core sampler; however, a stainless steel scoop may be used.

When fine grained materials are underlain by coarse materials, penetration of underlying sediments by corers or sludge samplers may be prevented. If this field condition exists, the sludge sampler, with its butterfly valve segment removed, may be inserted into the bed materials at an angle. This method will retain water which overlies the bed material.

When collecting composite samples of stream bed materials, collection of sub-samples (aliquots) will be performed at points along cross-sections of streams. More than one cross-section may be used to provide sufficient sample material. Samplers should move slightly upstream to collect additional aliquots along cross-sections to avoid impacting sample quality. Stainless steel scoops, core or sludge samplers should be used for this purpose. However, if penetration of sediments is not possible, a dredge (clam-shell) sampler may be used. If data objectives require that only the

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uppermost sediments be sampled, core samples may be partially taken at one point. The remainder of the composite may be taken at subsequent points along the cross-section.

When collecting composite samples of pond bed material, the preferred sampling strategy is to collect several aliquots from either randomly selected points or systematic grids at a sampling location. If sample points are randomly selected, they may be located near the center of the pond. If the location cannot be sampled without requiring the sampler to wade into the pond, the site should be sampled from a boat or with a dredge sampler. Extensions to the sampling devices may be required.

Organic material, rocks, or debris may be present in collected samples. These materials should be removed by sieving samples with a large screen sieve. Care should be taken in the selection of stream cross-sections and pond sampling grids to avoid collection of these materials.

5.4 SAMPLING PROCEDURES

Prior to sampling, initiate field notes regarding site conditions, sample team personnel, site identification, date, and sample identification. These items will be recorded on the Sediment Sample Collection Form found in Section 8.0, Documentation.

5.4.1 General Sampling Procedures

Typical steps to be followed in collecting any sediments are

1. Select the appropriate sampling method and equipment to be used
2. Decontaminate all sampling equipment

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- 3 Place all sampling equipment on plastic sheeting near the sampling location.
- 4 Collect samples
 - 4a The core sampler or the sludge sampler will be used to collect the top 2 inches of bed materials for VOC analysis. To collect a VOC sample, push the tapered end of the core sampler into the bed material. This can be facilitated by dropping the top weight onto the sampler shaft, if using a piston-type sampler. The sampler should be pushed in far enough to fill the 2-inch core liner. Enclose the sample in the corer, per manufacturer's instructions, and retract the corer from the sediments. Remove the core liner and seal as follows
 - Place Teflon® tape over the ends of the tube
 - Place liner caps securely over the Teflon® tape
 - 4b Non-sieved samples for grain size analysis will be taken with a core sampler or a sludge sampler. The method is the same as for VOC samples, however a full 6-inch core will be collected. Three 2-inch core liners will be used. This sample will be collected directly adjacent to the VOC sample location, in visually similar materials. Core will be sealed as described in 4a.
 - 4c. Composite samples for the remaining analytes described in the project work plan will be collected and placed in a mixing pan. Refer to specific procedures found later in this section for composite sample collection methods.

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5. Proceed to the sampling equipment location and then sieve the sample found in the mixing pan as described in Subsection 5.4.4, Sieving.
6. Mix the sample as described in Subsection 5.4.5, Mixing.
7. Fill sample containers for the remaining analytes. If liquid is present, attempt to maintain the proportion of solid to water that exists in the mixture while filling the sample containers, as discussed in Subsection 5.4.5, Mixing.
8. As each container is filled, carefully wipe the upper edges of the container with a paper towel so that sediments are removed from the threads and mouth of the jar. This is done to ensure that a tight seal exists after the container is closed.
9. After all sample containers have been filled, place the remaining sediment samples in an environmental container.
10. Decontaminate the sample containers by:
 - 10a. Rinsing the outside of the containers with distilled water.
 - 10b. Drying the outside of the containers with a paper towel.
11. Store all sample containers on ice in coolers for transportation.
12. Complete records of sample collection as described in SOP SW 1, Surface Water Data Collection Activities.

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13. Decontaminate equipment as described in SOP FO.3, General Equipment Decontamination

14 Perform personal decontamination as required by the HSP

5.4.2 Sample Collection Using a Dredge, Stainless Steel Scoop, Core Sampler, or Sludge Sampler in Streams

Refer to Subsection 5.3, Criteria for Selection of Sampling Methods and Equipment for instruction regarding stream bed material sampling.

VOC and non-sieved, grain size analysis samples will be collected and sealed as described in Subsection 5.4.1, General Sampling Procedures

The procedure for collecting streambed materials for other types of analyses using sampling devices described in Subsection 5.3, is as follows:

- 1 After determining the sampling point or points in the stream, either wade to the sampling point or place the proper number of extensions on the sampler to reach the proper point in the stream
- 2 If wading, be sure to hold the sampling device upstream from yourself (facing into the oncoming current)
- 3 Slowly lower the sampling device to the stream bottom

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- 4 After the sampling device reaches the bottom of the stream, penetrate bed materials with the sampling device, and follow the manufacturer's instructions for enclosing the sample in the device
- 5 Slowly raise the sampling device
- 6 Empty the contents of the sampling device into the mixing pan. If more than one point is being sampled in order to obtain several aliquots to produce a composite sample, proceed to the next sampling point and collect additional samples, as described in Steps (3) through (5). When practical, aliquots comprising a given composite should be approximately equal volume. A beaker or similar device may be used to measure the aliquots before they are placed in the mixing pan. This is done to avoid biasing the sample in favor of any grid points
7. Repeat Steps (3) through (6) until sufficient bed materials, as required by the project work plan, have been collected.
- 8 If sieving is required, sieve the materials as described in Subsection 5.4.4, Sieving.
- 9 Mix the sample material. Use the mixing procedure described in Subsection 5.4.5, Mixing.
- 10 Begin filling sample containers for the remaining analytes described in the project work plan.
- 11 As each container is filled, carefully wipe the upper edges of the container with a paper towel so that sediments are removed from the threads and mouth of the jar. This is done to ensure that a tight seal exists after the container is closed.

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Attempt to maintain the proportion of water to solids that exists in the mixing pan while filling containers, as discussed in Subsection 5.4.5, Mixing.

12. After all sample containers have been filled, place the remaining sediment samples in a environmental container
13. Decontaminate the sample containers by
 - 13a Rinsing the outside of the containers with distilled water
 - 13b Drying the outside of the containers with a paper towel.
14. Store all sample containers on ice in coolers for transportation
15. Complete records of sample collection as described in SOP SW.1, Surface Water Data Collection Activities
16. Decontaminate equipment as described in SOP FO.3, General Equipment Decontamination
17. Perform personal decontamination as required by the HSP.

5.4.3 Sample Collection Using a Dredge, Core Sampler, or Sludge Sampler in a Pond

Two approaches for collecting bed materials are provided in Subsections 5.4.3.1 and 5.4.3.2. One approach is to attach a sampling device to an extension rod or cable, and to use this device while standing on the shore of the pond to collect a sample or multiple samples for composting of bed

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material from the bottom of the pond. This approach will be used when the dimensions of the pond do not exceed approximately 30 feet in diameter or 3 feet in depth.

If the pond dimensions exceed these measurements, then the second sampling approach, namely sampling from a boat, as described in Subsection 5.4.3.2, will be employed. The field crew will row to the sample collection point or points in the pond and collect a sample of bed material in a dredge, core sampler, or sludge sampler, as determined in Subsection 5.3, Criteria for Selection of Sampling Methods and Equipment

5.4.3.1 Sediment Sampling From the Shore of the Pond

Ponds with dimensions not exceeding approximately 30 feet in diameter and 3 feet in depth will be sampled from the shore. The steps to be followed in obtaining bed material samples from these ponds are similar to sampling a stream from the shore of the stream. Refer to Subsection 5.4.1 for guidance in general procedural steps to be followed in collection of bed material samples from the shore of a pond. Refer to Subsection 5.3, Criteria for Selection of Sampling Methods and Equipment, for further instruction in collecting samples.

An important distinction between stream sampling and pond sampling is that in the case of sampling from a pond, due to the stagnant flow conditions in ponds, sampling personnel must not wade into the pond in order to obtain samples, because wading could agitate the bottom sediments and interfere with the collection of useful samples.

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5.4.3.2 Sediment Sampling From a Boat

Refer to Subsection 5.3 for instruction in the selection of sampling methods and equipment.

Ponds with dimensions in excess of approximately 30 feet in diameter and 3 feet in depth will be sampled from a boat. The steps to be followed in obtaining bed material samples from these types of ponds is as follows

- 1 Decontaminate the boat, anchor, and all sampling equipment in accordance with the procedures described in SOP FO.3, General Equipment Decontamination.
- 2 Arrange decontaminated sampling equipment, sample mixing tray, sample containers, and sample cooler on plastic sheeting inside the boat
- 3 Carefully launch the boat. Two samplers then enter the boat. A third crew member remains on shore
- 4 Row the boat to the first sampling point in the pond.
- 5 Anchor the boat
- 6 Slowly lower the sampling device over the side of the boat
- 7 Refer to Subsection 5.4.1. Perform Steps (4) through (14) to complete sampling operations

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5.4.4 Sieving

If required by the project workplan, sieve the material in the mixing pan. The object of sieving is to eliminate those particles greater in diameter than a particular, desired grain size

A number 10 mesh sieve should be used to remove all particles larger than 2 millimeters in diameter. If present, cobbles, large pebbles and/or pieces of vegetation should be removed from the sample. This is done by pre-sieving with a number 8 sieve. Record and perform sieving as follows

- 1 Size and type of sieve (for example 12-inch diameter brass with stainless-steel mesh)
- 2 Mesh size of sieve (for example number 10 sieve)
- 3 Sieve the entire volume of collected sediments
- 4 Collect sieved sediments in mixing pan

5.4.5 Mixing

Sediments collected for analyses of constituents other than VOCs and the non-sieved grain size samples will be thoroughly mixed before the samples are placed into the sample containers. In addition, the samples may be sieved prior to mixing, as discussed in Subsection 5.4.4, Sieving. The sediment will be removed from the sampling device and placed in a glass container, Teflon®-coated stainless steel pan, or a stainless steel pan then mixed using a stainless steel or Teflon®-coated stainless steel spoon or a stainless steel scoop. The sediment will be scraped from the sides, corners, and bottom of the pan, rolled to the center of the pan, and mixed.

The sample is then to be quartered and moved to the four corners of the mixing pan. Each quarter of the sample will then be mixed individually. Each quarter is then rolled to the center of the

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container, and the entire sample is mixed together. This procedure will be continued to ensure that all parts of the sample are mixed as well as possible, and that the sample is as homogeneous as possible before being placed in the sample containers. Mixed samples are then placed in sample containers.

If water is present in the sample mixture that is obtained by use of a sludge or core sampler, then an attempt will be made to preserve the water-to-solid ratio by including the water as part of the sample. This will be done by following these measures:

- 1 Use the stainless steel scoop to place scoops full of sample/water mixture into each jar.
- 2 Remix the sample/water mixture remaining in the mixing pan after each scoop of material is placed in a sample jar.
- 3 Fill each sample container only partially. Then, beginning with the first container, add additional sample to each container. Continue in this manner until all containers have been filled. This approach is used to evenly distribute the liquid into the various sample containers, while endeavoring to maintain the solid-to-liquid ratio present in the samples collected in the core or sludge sampler.
- 4 If the mixture is high in liquid content, the mixture may be poured into a stainless steel beaker in order to more efficiently transfer the mixture into sample containers. Continued mixing with a spoon will be provided to maintain homogeneity of the sample mixture during filling of sample bottles, as discussed in (3) above.

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5.4.6 Sampling Dry Sediments

Sampling personnel will be required to wear level C personal protective equipment (including a respirator) in order to perform sampling of dry sediments. Refer to the Health and Safety Plan for a description of procedures and equipment

For the case of sampling dry sediments, procedures are as follows

- 1 Collect samples for analysis for VOCs in the core sampler or sludge sampler. Follow the steps outlined in Subsection 5.4.1, Step (4a). If unable to collect sufficient sample material with the core samples, use the stainless steel scoop.
- 2 Collect samples for non-sieved grain size analysis in the core samples. If unable to collect sufficient sample material with the core samples, use the stainless steel scoop. Follow the procedure outlined in Subsection 5.4.1, Step (4b).
- 3 Collect dry samples from discrete points by use of the stainless steel scoop. Place the samples into the mixing pan. Continue collection until sufficient materials have been obtained. Follow Steps (8) through (17) in Subsection 5.4.1 to complete sampling.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP.

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QC samples for sediment sampling fall into two categories

- Duplicate
- Equipment rinsate

SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples describes the general handling of samples. The Workplan/Quality Assurance Addendum (QAA) specifies QC sampling frequencies.

Sample collection procedures for duplicate samples will be the same as those described for regular samples in Section 5.0. These samples are intended to be as close to exact replicates of the original samples as possible. They are obtained immediately adjacent to the samples that they are intended to duplicate.

A rinsate sample from sampling equipment is intended to check for potential contamination of the sample by the sampling equipment. The equipment rinsate is a measure of the quality of decontamination procedures. For the bed material sampling operation, a rinsate sample will be collected from sampling equipment with any liners in place before the sampling equipment is used. Sampling equipment will be rinsed with approximately 3 liters of distilled water which will be collected in a decontaminated stainless steel bowl. A decontaminated glass or stainless steel beaker will be used to dip the water from the bowl and fill the sample bottles. The rinsate samples will be analyzed for the same parameters as the bed material samples.

7.0 ENVIRONMENTAL MANAGEMENT

Sampling sites associated with environmental restoration at RFP fall into two categories: potentially contaminated and not potentially contaminated. Background locations are identified in SOP FO.10, Receiving, Labeling, and Handling Environmental Materials Containers. At sediment sampling

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stations that have not been verified as background locations, environmental materials will be handled in accordance with SOP FO 10.

Sediment stations which have been identified as not potentially contaminated, environmental materials will be handled in accordance with

- SOP FO 6, Handling of Personal Protective Equipment
- SOP FO 7, Handling of Decontamination Water and Wash Water
- SOP FO 9, Handling of Residual Samples

8.0 DOCUMENTATION

Information required by this SOP will be documented on the Sediment Sample Collection Form (Form SW 6A) that follows

SEDIMENT SAMPLE COLLECTION FORM

SAMPLE ID: _____ SITE ID: _____ LOCATION: _____

NORTH OR Y: _____ EAST OR X: _____

COLLECTION DATE: _____ QUARTER: 1 2 3 4 DRY: Y / N

COLLECTION TIME: _____ PURPOSE: _____

COMPOSITE Y / N

COMPOSITE DESCRIPTION: _____

QC TYPE REAL MS MSD LR DUP RNS QC PARTNER: _____

COLLECTION METHOD: Scoop _____ Dredge _____ Core _____ Other _____

SIEVED: Y / N SIEVE SIZE NO: 10

SIEVE MATERIAL: FRAME _____ SCREEN _____

TEAM LEADER _____ TECH _____ TECH _____ TECH _____

VOLUME COLLECTED: _____ UNITS: _____

DEPTH OF WATER: _____ Feet

DEPTH OF TAKE: _____ Inches

COMMENTS: _____

SAMPLED FROM

Shore Stream Boat Bridge Cross-Section Dry Area Other _____

SAMPLING CONDITIONS.

Stream Pond Dry Other _____

WEATHER.

Clear Calm Hot Sunny P/C Lt Breeze Warm Fog Cloudy Windy Cool Rain

Gusty Cold Sleet V Cold Snow Other _____

MATRIX. _____

REQUEST FOR ANALYSIS NO: _____

CHAIN OF CUSTODY NO: _____

SHIP DATE: _____

Sampler _____

Prepared by _____

Print Name

Signature

Company _____

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TITLE
 COLLECTION OF TAP
 WATER SAMPLES

Approved By

[Signature]
 (Name of Approver)

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used for the Rocky Flats Environmental Management (EM) Program and is applicable to the collection of water samples from all taps and valves that provide for the free flow of water when the valve is in the open position. This SOP also describes personnel responsibilities and qualifications, sample collection and preservation procedures, quality assurance/quality control (QA/QC), and documentation requirements that will be used for field data collection activities in order to attain acceptable standards of accuracy, comparability, representativeness, and completeness.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing these procedures are required to have the appropriate health and safety training as specified in the site-specific Health and Safety Plan. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

Personnel performing tap water sampling activities will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

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4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure

A Compendium of Superfund Field Operations Methods EPA/540/p-87/001 U S Environmental Protection Agency December 1987

DOE 1987 The Environmental Survey Manual. DOE/EH-0053, Volumes 1-4 U S Department of Energy August 1987

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA EPA/540/g-89/004, U S Environmental Protection Agency Interim Final October 1988

RCRA Facility Investigation Guidance Environmental Protection Agency Interim Final May 1989

Microbiological Methods for Monitoring the Environment, Water and Wastes Environmental Monitoring and Support Laboratory, Cincinnati EPA-600/8-78-017-December, 1978

Standard Methods for the Examination of Water and Waste Water APHA-AWWA-WPOF-17th Edition, 1989

NPDES/FFCA Operations Sampling Plan Environmental Management Surface Water Division, Rocky Flats (In progress)

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4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows

- SOP FO.3, General Equipment Decontamination
- SOP FO 7, Handling of Decontamination Water and Wash Water
- SOP FO 11, Field Communications
- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP FO 14, Field Data Management
- SOP GW.5, Measurement for Groundwater Field Parameters
- SOP SW 2, Field Measurement of Surface Water Field Parameters

5.0 METHODS

Collection of representative tap water samples through grab sampling of taps, valves, or faucets requires that a reliable SOP be written and implemented. A number of factors may need consideration. For instance, the presence or absence of a holding tank will have an effect on values and stabilization times for parameters such as volatile constituents, pH, and temperature. The following procedure will be utilized to collect samples from taps, valves, or faucets:

- Gloves will be worn by the sampler at all times during the sample collection. Sterile gloves will be worn for collection of bacteriological samples. To avoid contaminating the sample, the inside of the cap and the sample bottle must not be touched with the fingers nor allowed to touch the tap or ground. In order to avoid dislodging particles in the faucet, it is important that the tap's stream flow not be adjusted during sampling.

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- The sample is to be collected from the first accessible point at the sampling site. All sampling must be done prior to any filtration or other treatment. If the tap contains an aerator or strainer, it should be removed. Purging is not required at off-site community taps.
- Remove all hoses or any other attachments from the tap to be sampled. If the tap is located in an area where the discharge cannot be allowed to flow onto the ground, the hose may remain attached to the tap throughout the 10-minute purge or throughout the 1-minute purge when sampling carbon treatment systems or 30 second purge when sampling ion exchange and/or ultraviolet/hydrogen peroxide treatment system, however, before sampling, the hose must be removed and the tap purged for an additional 2 minutes before sampling. Leaving the hose attached during purging should be avoided if possible.
- If bacteriological samples are to be collected, the tap will be heated with a flame from a lighter or burner for 15 seconds before beginning purging. Use NaOCl solution (100 mg/L) or household bleach diluted 2 mls/L and place end of faucet in solution or squirt solution in and on faucet from a squeeze bottle.
- Purge the line by adjusting the cold water side of the tap to provide a smooth-flowing water stream at a moderate pressure that prevents splashing, and record the time that the purging was initiated on the tap water sampling log sheet. Ideally, if volatile organic compounds (VOC) samples are to be collected, the flow rate should not exceed 100 ml/min. However, the primary consideration will be to provide a smooth flowing water stream at a moderate pressure that will minimize aeration of the sample.

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- Purging of non-mixing faucets Remove screen if present Run cold water line for half of purging time Shut off water Disinfect faucet Turn on cold water for remaining purging time
- Purging of mixing faucet Remove screen Run hot water line for half of purging time Shut off water Disinfect faucet Turn on cold water line and run water for remaining purging time
- Purging drinking well water samples Purge for a minimum of five minutes
- Estimate the rate of purging by measuring the volume collected in a 250 ml to 1-liter graduated cylinder depending on flow rate, over a 15- to 30-second period The collection period will be timed with a stopwatch The volume collected in liters will be divided by the time in seconds and then multiplied by 60 seconds per minute to yield the evacuation rate in liters per minute Record this information on the tap water sampling log sheet
- Allow the water to purge for at least 10 minutes, or if sampling carbon treatment systems, allow the water to purge for at least 1 minute (if sampling ion exchange system purge for at least 30 seconds) before collecting the first sample to ensure that the sample will be free of any rust or residue that may be in the tap If not free of rust and residue after 10 minutes, continue to purge until the water is visibly clear or until field parameters have stabilized Record the completion time of purging, the total duration of the purging event and calculate and record the estimated volume of water purged by following the equation given on the tap water collection log sheet

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- When sampling water from a groundwater well, measure the pH, temperature, and conductivity of the water a minimum of three times during purging to determine if measured parameters are stable at the time of sampling by following SOP SW 2, Field Measurement of Surface Water Field Parameters. Record these values as well as the time the sample was taken for each set of readings on the tap water collection log sheet. Measurements will be a minimum of 2 minutes apart. Field parameters will be considered stable when two consecutive readings for pH, conductivity, and temperature taken at least two minutes apart, differ by less than 10 percent.
- Record any unusual observations about the water during purging, such as color or odor, record the time that purging is completed, and record the length of the purge cycle.
- During purging, check for the presence of total residual chlorine by following procedures in SOP SW 2, Field Measurement of Surface Water Field Parameters. TFC will be checked after purging and collection of bacteria sample have been performed.
- Collect the sample at the same flow rate as the purge flow rate by removing the cap of the specified container and placing the container under the tap until it is full. Hold the bottle in one hand and the cap in the other, right side up (threads down), while collecting the sample. If the cap liner or septum has a tendency to fall out of the cap, the cap and liner/septum should be placed on a sheet of plastic with the thread side down.
- Collect the samples in the order specified in Table SW 7-1. Sampling at each site will be specific to the needs and requirements for that site as determined by the

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site supervisor The full set of parameters listed in Table SW 7-1 will not always be collected at each site, and additional parameters may be required in some instances

- After collecting the sample, replace the cap, apply a tamper-proof seal (for bacteria samples going to 123 lab), place the bottle in a plastic bag (unless samples are going to on-site lab), and store in a cooler at 4 °C
- Turn off the water supply and replace any aerators, strainers, hoses, or other attachments that were removed.
- Complete all chain-of-custody forms and documentation at the time the samples are collected

TABLE SW.7-1
SAMPLE PARAMETERS AND ORDER OF FIELD COLLECTION

Total coliform
Fecal coliform
Heterotrophic plate count
TCL VOCs
TCL BNAs
Pesticides/PCBs
TAL Metals (dissolved) ^(a)
Nitrate/Nitrite as N
Major Ions ^(a) , TSS, TDS
Cyanide
Radionuclides - Total ^(a)
Tritium

^a See Table SW 7-2 for individual analytes

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Sample containers will be precleaned or purchased precleaned before use in the field. All containers, preservatives, and holding times will conform to EPA requirements as listed in Table SW 7-2. Additional information on containers, preservatives, and holding times may be found in SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

Subsequent to sampling, all samples will be placed in sample coolers. The temperature inside the cooler will be cooled to 4°C. This temperature will be maintained by adding blue ice sealed in plastic bags.

6.0 DECONTAMINATION

Equipment will be decontaminated after use at each site. Procedures for decontamination are set forth in SOP FO 3, General Equipment Decontamination.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

QA samples for tap water sampling fall into one category:

- Duplicate

SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples describes the general handling of samples. Applicable project plans specify QA sample frequencies.

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TABLE SW.7-2
CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

<u>Parameter</u>	<u>Container</u>	<u>Preservative</u>	<u>Holding Time</u> <u>(Days)</u>
TCL VOC	2 glass 40-ml vial w/Teflon®-lined	Approx. 10 mg Na ₂ S ₂ O ₃ ^(a) , HCL to pH <2.0	7 days 14 days
TCL BNA	Silicon Rubber Septum Glass-Amber/2 x 1 L	4°C 4°C Na ₂ S ₂ O ₃ ^(a)	7 days to extraction 40 days after extraction
Pesticides/PCB	Glass-Amber/2 x 1 L	4°C	7 days to extraction 40 days after extraction
TAL Metals (dissolved) ^(b)	Polyethylene/1 x 1 L	Filter ^(c) , HNO ₃ to pH <2, 4°C	180 ^(d)
TAL Metals (total)	Polyethylene/1 x 1 L	HNO ₃ to pH <2, 4°C	180 ^(d)
Total Coliform	Sterile polyethylene or glass/1 x 125 ml	0.1 ml of 10% Na ₂ S ₂ O ₃ , 4°C lab bottles are pre-preserved	6 hours
Fecal Coliform	Sterile polyethylene or glass/1 x 125 ml	0.1 ml of 10% Na ₂ S ₂ O ₃ , 4°C lab bottles are pre-preserved	6 hours
Heterotrophic Plate Count	Sterile polyethylene or glass/1 x 125 ml	0.1 ml of 10% of Na ₂ S ₂ O ₃ , 4°C lab bottles are pre-preserved	6 hours
Cyanide	Polyethylene/1 x 1 L	NaOH to pH > 12, 4°C, 0.6 grams ascorbic acid ^(a)	14 days
Major Ions ^(e)	Polyethylene/1 x 1 L	4°C	See footnote (f)

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TABLE SW.7-2
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Parameter	Container	Preservative	Holding Time (Days)
Nitrate + Nitrate as N	Polyethylene/100 ml	H ₂ SO ₄ to pH < 2, 4°C	28 days
TSS and TDS ^(a)		4°C	7 days
Radionuclides ^(b)			
Total	Polyethylene/3 x 3 79 L	HNO ₃ to pH < 2	180 days
Tritium	Glass/100 ml	None Required	180 days
Radiation			
Screen	Plastic/250 ml	None Required	Not Applicable (i)

(a) Should only be added if measurable (greater than 0.2 ppm) residual chloride is present

(b) ~~TAL~~ metals are Al, Sb, As, Ba, Be, Cd, Ca, Cr (total), Co, Cu, Fe, Pb, Mg, Hg, Ni, K, Se, Ag, Na, Tl, V, and Zn. Additional parameters to be analyzed are Cs, Li, Mo, Sn, and Sr

(c) A 0.45-micron filtering apparatus will be used

(d) Holding time for mercury is 28 days

(e) The requested major ions are CO₃, HCO₃, F, Cl, SO₄, and PO₄

(f) Holding times for the requested major ions are as follows: CO₃ and HCO₃, 14 days; Cl, F, SO₄, 28 days; and PO₄, 48 hours

(g) TDS (Total Dissolved Solids) and TSS (Total Suspended Solids) will be collected in the same sample container as the Major Ion analysis

(h) Radionuclides are gross alpha and beta, Pu-239, Pu-240, Am-241, U-233, 234, 235, and 238, Sr-90, Cs-137, Ra-226, and Ra-228

(i) Radiation screening samples are analyzed by an on-site EG&G lab and are typically analyzed within 24 hours of collection

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Sample collection procedures will be the same as those described in Section 5.0 of this SOP for duplicate, matrix spike, and duplicate matrix spike samples. These samples are intended to be as close to exact replicates of the original samples as possible. They are obtained immediately adjacent to the planned samples they are intended to duplicate.

Field blank samples are containers filled with clean water that are handled and transported the same as the other samples to check for potential cross-contamination resulting from field handling and transportation procedures.

8.0 DOCUMENTATION

A permanent record of the implementation of this SOP will be kept by documenting field observations and data on the tap water sampling log sheet (Form SW 7A and SW 7B). Observations and data will be recorded with black waterproof ink. Field logbooks and NPDES/FFCA daily log sheets for bacteriological sampling will be utilized to summarize the daily field activities and to document project information not required by the field forms. Initials of the individual entering the information onto the form should be written next to each entry as it is made.

ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT PROGRAM
TAP WATER SAMPLING LOG SHEET

Site ID Number _____

Date ____/____/____

Location _____

WATER USE

☐ SINGLE FAMILY☐ MULTIPLE FAMILY☐ LIVESTOCK☐ COMMERCIAL☐ OTHER (SPECIFY) _____

WATER SOURCE

☐ PUBLIC WATER SUPPLY ☐ GROUNDWATER WELL☐ OTHER (SPECIFY) _____

PURGING

START TIME _____ COMPLETION TIME _____

DURATION OF PURGE _____

PURGE RATE _____ (VOLUME-L) X _____ (TIME-SECONDS + 60) = _____ LITERS/MINUTE

ESTIMATED VOLUME PURGED _____

PURGE RATE _____ (L/MIN) X DURATION _____ (MIN) = _____ LITERS

ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT PROGRAM
TAP WATER SAMPLING LOG SHEET

FIELD MEASUREMENTS DURING PURGING

Volume Purged (liters)	Temp (°C)	Specific Conductance (μ S/cm)	pH	Time	Water Description

OBSERVATIONS

**ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT PROGRAM
GROUND/SURFACE WATER TREATMENT SYSTEM SAMPLING LOG SHEET**

[illegible]

POND SAMPLING

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**TITLE
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Approved By:

(Name of Approver)

MAY 12, 1992

(Date)

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2.0 PURPOSE AND SCOPE

This SOP describes procedures that will be used to collect surface water samples and measure field parameters from ponds at Rocky Flats Plant (RFP). Specifically, this SOP describes methods to be used for pond sampling and for measurement of field parameters in water from ponds that will be used for field data collection and documentation to attain acceptable standards of accuracy, precision, comparability, representativeness, and completeness.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

Personnel active in obtaining pond water samples or measuring field parameters of pond waters will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under the supervision of another qualified person.

3.1 NOTIFICATION AND LOGISTICS

The Site Supervisor will be responsible for determining the necessary notifications and authorizations required to (1) coordinate sampling activities with interested parties and (2) address access and security concerns for specific sampling sites.

Sampling of terminal ponds (A4, B5, C2) may be necessary prior to the periodic need to discharge water from each pond. EG&G will notify the Department of Energy (DOE) three days prior to any predischARGE sampling event. At least 48 hours prior to the intended time of sampling, DOE will contact the interested parties of the Colorado Department of Health (CDH), the City of Broomfield, and the City of Westminster so that they will have an opportunity to receive split samples. Access to the site will be coordinated through the EG&G project manager. Note: RFP access and control procedures are subject to change. Contractors will be notified of any such

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changes by an EG&G contact. The Site Supervisor will be responsible for notifying sampling personnel of these changes.

3.2 POND SAMPLING TEAMS

If pond sampling is to be performed from a boat, the pond sampling team will consist of three people. If pond sampling is to be performed from the shore, then only two people are required on the sampling team. In either event, one of the team members will be designated by the Site Supervisor or by the EG&G representative to be the team leader. When pond sampling takes place from a boat, two team members will work out of the boat, while the third team member remains on shore.

All team members will assist in preparing the sampling and data collection equipment as described in SOP SW 1, Surface Water Data Collection Activities, decontaminate the equipment as detailed in SOP FO.3, General Equipment Decontamination, and transport the equipment to the field site. The two crew members in the boat will perform the majority of the data collection and sampling activities. The third person on the shore shall be responsible for the following:

- Assist in locating proper sampling points
- Monitor all sampling activities
- Perform emergency response activities as detailed in the Health and Safety Plan (HSP)
- Measure field parameters

Drowning is a danger for a person suited in protective equipment because the weight of protective equipment increases the person's weight and impairs swimming ability. Therefore, the HSP should be consulted prior to data collection activities at any pond to determine the appropriate level of protection required for site activities at the pond.

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4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure

A Compendium of Superfund Field Operations Methods EPA/540/P-87/001 December 1987

Detention Pond Sampling Plan Draft Environmental Management and Assessment Division
Rocky Flats Plant February 1990

Energy, Safety, and Health Directive DOE 5400 1 November 9, 1988

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA Interim
Final EPA/540/G-89/004 October 1988

RCRA Facility Investigation Guidance Interim Final May 1989

The Environmental Survey Manual Appendixes E, F, G, H, I, J, and K. DOE/EH-0053/Vol 4
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4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows:

- SOP FO.3, General Equipment Decontamination
- SOP FO 6, Handling of Personal Protective Equipment
- SOP FO 7, Handling of Decontamination Water and Wash Water
- SOP FO 9, Handling of Residual Samples
- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP GW 6, Groundwater Sampling
- SOP SW 1, Surface Water Data Collection Activities
- SOP SW.2, Field Measurement of Surface Water Field Parameters
- SOP SW 3, Surface Water Sampling

5.0 METHODS

5.1 SELECTION OF SAMPLING METHODS AND LOCATIONS

As described in the introduction to this SOP, different field conditions will impact the type of sampling methodology that may be used. Ponds in which the entire surface area is frozen may be sampled only from shore. Further, high winds prevent the use of a boat on any pond. The site safety officer will make the judgement of when to cease sampling efforts in the event of high winds.

When sampling frozen ponds, boats will be used as sampling platforms to provide safety in the event the ice breaks. The boat will be secured with an anchor tied to the bow or stern and secured to the shore. Sampling will be performed from the opposite end of the boat. An auger will be used to

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drill a hole through the ice. The remaining steps in the sampling process are the same as described in Subsection 5.4.2.1, Sampling From a Boat.

Certain parameters will be measured at each sampling event to determine if stratification and/or a lack of mixing of water exists in the ponds. Stratification of water layers in ponds is usually caused by water temperature differences. Cooler, denser water lies beneath warmer water. Subsection 5.4.1, Field Parameter Measurements, describes measurement of dissolved oxygen (DO) and temperature profiles which will be used to identify stratified layers or a lack of mixing. The results of this profile will be used to determine sampling methodology.

Vertical composites and/or non-composited samples shall be collected from a boat at the deepest point in ponds. The deepest point of the pond is considered to be at the middle of the dam 10 to 15 feet from shore. Water samples and/or field parameters may be collected from multiple or randomly selected points in the ponds when requested. Refer to SOP SW.2 for a description of field parameter measurements.

Specific sampling events need to be considered if data collection objectives are not met by standard collection methods, or if interested parties request deviations from these sampling guidelines. One such deviation, the collection of split samples with the CDH, is described in Subsection 5.4.2.4, Collecting Split Samples. Such specific requests shall be considered on a case-by-case basis.

5.2 SAMPLE CONTAINERS, PRESERVATION, AND HANDLING

In general, sample containers used for pond sampling may be prepared and handled as described in SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. However, in the case of collecting composite samples directly into the containers, advance container preparation detailed in Subsection 5.2.1, Preparation of Sample Bottles to be Used for Composite Samples, will be required.

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5.2.1 Preparation of Sample Bottles to be Used for Composite Samples

Composite sample container preparation is as follows

- Prepare a complete set of reference bottles to be kept in the base lab as follows
For each sample bottle size to be used, prepare a reference bottle, by accurately dividing the bottle into volumetric thirds and halves using a graduated cylinder, potable water, and a permanent marker
- Using the reference set of bottles as guides, divide the sample bottles into volumetric thirds (or halves) by marking each bottle at the volumetric third (or half) points with a permanent marker

5.3 EQUIPMENT

All sampling equipment that is neither dedicated nor disposable will be constructed of inert organic materials or of stainless steel. The specific equipment items to be used for pond sampling are listed in Subsections 5.3.1 and 5.3.2.

Equipment used in boats to collect samples or measure field parameters will be organized to prevent the interaction of clean equipment with used equipment, sample water, or environmental samples. As much as is reasonably possible, equipment that does not float will be attached to a flotation device or the boat to prevent loss. Instruments that can be damaged by water will be stored in water-tight containers when not in use.

For most pond sampling events, the following equipment will be used in addition to some or all of the usual surface water sampling equipment listed in SOP SW 1, Surface Water Data Collection Site Plan.

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- Discrete zone sampling device
- Peristaltic pump and tubing composed of inert material
- Depth measuring devices

5.3.1 Field Parameter Measuring Equipment

Equipment described in SOP SW.2, Field Measurement of Surface Water Parameters, may be used in measuring field parameters in ponds. Exception to the methods listed in SOP SW.2 are listed in this section.

5.3.2 Hydrolab Multi-Parameter Measuring Instrument

The Hydrolab Multi-Parameter Measuring Instrument, or similar multi-parameter instruments, may be used for measuring pH, temperature, specific conductance, D O., redox potential, depth, and salinity. This instrument enables field measurement and graphic display of vertical field parameter profiles as they are measured in a pond. The Operation and Maintenance Manual shall be followed when operating or calibrating the instrument.

5.4 PROCEDURES

This section discusses measurement of field parameters and collection of surface water samples.

5.4.1 Field Parameter Measurements

Field parameters shall be measured and recorded as described in SOP SW.2, Field Measurement of Surface Water Parameters. When available, a multi-parameter measuring instrument may be used for all measurements, except alkalinity and total residual chlorine (TRC). Refer to the multi-parameter measuring instrument manual for equipment specific procedures.

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Prior to the sampling event a D O and temperature profile will be made at the sampling location. Measurements to construct the profiles will be taken starting 1½ feet from the bottom and taken at one foot increments to one foot below the surface. The total depth shall be recorded at this time. This shall be done with a D O meter or a multi-parameter measuring device. Observation of the D O and water temperature may determine if a Redox boundary exists. EG&G personnel should be notified on a same day basis when one or both of the following conditions exist.

- There is a 1°C or greater temperature change over 3.3 feet (1 meter) depth
- The maximum and minimum D O measurements vary by more than 5 mg/l

If neither of these criteria are met, samples will be collected, at the depths described below, and composited (except in ponds of depth less than 4.5 feet). If one or both of the above criteria are met, the collected samples will not be composited. A unique sample number will be assigned to the set of analytes for each discrete sample interval.

- When pond depth is less than 4.5 feet, a discrete suite of samples will be taken at mid-depth
- Ponds with depths between 4.5 and 6.5 feet will be sampled at two intervals. The sampling depths will be separated by at least two feet. Collect one sample between mid-depth and one foot below water surface, and the second between mid-depth and 1.5 feet from the pond bottom. If no D O or temperature stratification is indicated, these samples are to be composited.
- Ponds with depth greater or equal to 6.5 feet will be sampled at the following depths

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- One foot below the surface
- Mid-depth of the pond
- One and a half feet above the bottom of the pond

Again, if no D O or temperature stratification is indicated, these samples are to be composited

When samples are composited, refer to Subsection 5.4.2.1, Sampling From a Boat, for sampling procedures. When discrete depth samples are taken, refer to Subsection 5.4.2.3, Non-composite Samples.

If a multi-parameter measuring instrument is available, follow equipment specific instructions for determining total water depth. Special care should be taken to avoid excess disturbance of bottom sediments when determining water depth by either method.

5.4.2 Water Sampling Procedures

When samples can be collected from the approximate center of small ponds from shore without wading, they will be collected in accordance with Subsection 5.3.6, Sampling of Standing Water, of SOP SW.3, Surface Water Sampling.

5.4.2.1 Sampling From a Boat

The following procedures describe the general activities to be performed when water samples are collected from a boat. All sampling activities will be performed from the back of the boat. The field parameters, dissolved oxygen, water temperature, specific conductance, and pH, may be measured in the boat using a multi-parameter measuring device or on shore. Alkalinity and total residual chlorine (TRC) will be measured on shore.

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- Collect Oil and Grease samples by partially immersing the sample bottle at the pond surface, taking care not to interfere with the movement of the product into the container
- If no multi-parameter sampling device is available, use a discrete zone sampler to collect water for field parameters. One type of discrete zone sampler is an extension rod with a clamp that can hold a glass sampling bottle securely. Built into the frame of the rod is another rod with a ball on the top end and a suction cup on the bottom end. To collect a sample, lower the bottle to the proper depth and rotate the ball counterclockwise to remove the bottle lid by suction. Air bubbles will rise to the surface. When bubbles have stopped, rotate the ball clockwise to close the lid. The sample bottle can then be raised and removed from the rod. Transfer the sample to an unbreakable sample container while minimizing agitation of the sample. Deliver the sample container to the technician on shore for performance of field parameter measurements.
- If multi-parameter equipment is used, the grab sample for alkalinity and TRC measurements will be collected with a discrete sampler.
- Samples for analysis of all parameters except volatile organic compounds (VOCs), field parameters, and rad screens will be collected by the use of a peristaltic pump. Samples will be prepared as follows:
- A Geopump or equivalent peristaltic pump, with an adequate length of Teflon® or polyethylene intake tubing will be used to collect the sample. The intake for the tubing must be attached to a water depth measuring device so that technicians are certain to collect all samples from the same depth.

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- This sampling device will be lowered to the proper sampling depth, as described in Subsection 5 4 1 Samples requiring filtration will be collected first by pumping through a disposable inline 0 45-micron filter Sample containers (except for volatiles and rad screens) will be filled (partially for composites), capped, and stored in iced coolers The containers will have been previously marked to permit ease in properly filling to the appropriate volumes
- The discrete zone sampler will be used to collect VOC samples by following the above procedures The collected sample is carefully poured into a VOC bottle, leaving no headspace If a VOC bottle is observed to contain bubbles after it is filled, the bottle must be disposed of and replaced with a new bottle for use in sampling VOCs will be collected at the uppermost sampling level if samples are being composited
- The water remaining in the discrete sampler after the VOC sample has been decanted into the VOC bottle may be used for a rad screen sample and field parameters
- Sample bottles partially filled will be composited with an equal portion of water collected from subsequent sample interval(s) with the peristaltic pump
- Field parameters shall be measured at each sampling interval in the manner described above for the initial interval
- Special care will be taken to avoid any disturbance of bottom sediments

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5.4.2.2 Small Pond Sampling From Shore

- Sampling of small (non-terminal) ponds will routinely be accomplished by collection of samples from the shore
- Field parameters shall be collected by the dip and transfer method, as described in SOP SW.3 Surface Water Sampling
- VOCs shall be collected by the sample container immersion method following SOP SW.3, Surface Water Sampling
- Oil and Grease shall be collected as described in Subsection 5.4.2.1 Sampling From a Boat
- Other samples shall be collected with the use of a Geopump or equivalent peristaltic pump. An adequate length of Teflon® or polyethylene tubing will be used to collect the sample. The tubing intake shall be tied to the end of a twelve foot stainless steel rod
- A float shall be attached to the end of the rod and the tubing positioned in such a manner that the sample is collected one foot below the surface of the water. The full length of the rod shall be extended into the water and the samples collected from the midpoint of the dam side of the pond. During snowy or other hazardous conditions, the samples can be collected from an easily accessible location away from the dam

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5.4.2.3 Non-Composite Samples

The procedures for sampling without compositing are the same as in Subsection 5.4.2.1, Sampling From a Boat, with the following exceptions

- Samples will not be composited.
- Sample bottles will be completely filled at each of the three sampled zones (see Subsection 5.4.1)
- Each sample will require a separate sample identification number

This method will require more sample bottles than called for in the general procedures. Arrangements should be made prior to the sampling events to provide for use of this method.

5.4.2.4 Collecting Split Samples

CDH or the city of Broomfield may request that sampling be performed from the shore so that CDH personnel may actively participate in sample collection with the surface water sampling teams. Therefore, when collecting split samples in conjunction with CDH, the following guidelines may be employed:

- Sampling will be performed from the shore.
- The location to be sampled will be designated by CDH.
- CDH and/or Broomfield and the contractor will perform split sampling as described in the following steps:

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- 1 Sample bottles will be filled by CDH and the field technician by taking turns partially filling the bottles in the following manner
 - CDH will half-fill a bottle, then the field technician will half-fill a similar bottle
 - CDH will finish filling their bottle, then the technician will complete filling their bottle
- 2 VOC bottles will be filled in one step, not by half-filling bottles, as described above
- 3 CDH will direct the order in which samples are collected
- 4 The field technicians will measure and record field parameters
- 5 When bottle sizes differ between CDH and EG&G, the bottles are filled proportionately. Fill both bottles 1/3 of the way for each depth, for samples composited from three depths

5.4.2.5 Collecting Pre-Discharge Samples at A4 and C2 Ponds

Pre-Discharge samples will be collected at A4 and C2 ponds at the direction of EG&G. The samples will be collected in accordance with section 5.4.2.1, Sampling from a Boat and section 5.4.2.4, Collecting Split Samples.

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5.4.2.6 Samples for Bacteriological Examination

Samples for bacteriological examination must be collected in bottles properly sterilized and protected against contamination. The preferred method is to scoop up the water with an open bottle just below the surface of the water. This method is usually used when sampling from a boat. While the bottle is open, both the bottle and the stopper must be protected against contamination. A small amount of water should be poured from the bottle after filling to leave an air space for subsequent shaking in the laboratory. The bottle should be closed at once.

5.4.2.7 Samples For Dense Non-Aqueous Phase Liquids (DNAPLs) and Light Non-Aqueous Phase Liquids (LNAPLs)

When an occurrence of DNAPLs and/or LNAPLs is suspected, by visual observation, detectable odor, or is a known spill, it shall be sampled. The appropriate method for detecting these layers is discussed in SOP GW 1, Water Level Measurements in Wells and Piezometers. LNAPLs shall be collected with a bottom valve bailer or peristaltic pump. DNAPLs shall be collected with a bottom double check valve bailer or peristaltic pump.

Water containing LNAPLs will be checked for the presence of DNAPLs by lowering the pump intake or bailer to the bottom of the pond and collecting the first water from the bottom of the pond in a 1-liter glass container. The container will be initially checked with an organic vapor analyzer (OVA) for the presence of organic vapors. The liquid in the glass container will be allowed to stand for 15 minutes and visually observed for the presence of separate phases. If no DNAPLs have separated out of the solution after 15 minutes, the water will be presumed free of DNAPLs.

In all cases, care shall be taken to carefully lower the bailer into the water so that agitation of the immiscible layer is minimal. Any bailer used to collect immiscible layers will be dedicated to the

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pond which is sampled Peristaltic pumps will be equipped entirely with siliceous tubing when sampling immiscible layers Dedicated equipment used for collecting immiscible layers shall be decontaminated prior and after use as described in Subsection 5.3 of SOP GW 6, Groundwater Sampling. Immiscible layer sampling shall be performed as follows

- Dedicated bailers will be removed from the sampling site and decontaminated as specified in Subsection 5.3 of SOP GW 6, Groundwater Sampling Dedicated pump tubing if used shall also be decontaminated prior to use
- For light non-aqueous phase liquids (LNAPLs), the bailer will be carefully lowered to the midpoint of the immiscible layer and allowed to fill while it is being held at this level The bailer must be lowered into the immiscible layer slowly so that minimal agitation of the immiscible layer occurs Peristaltic pump intakes will also be lowered to the midpoint of the immiscible layer when used

If a DNAPL layer is being sampled, either the double check valve bailer or peristaltic pump shall be used The bailer will be lowered into the water until the bottom is encountered Peristaltic pump intakes will also be lowered to the bottom Care must be taken not to submerge the pump intake into, or disturb the bottom sediments

- At no time should the bailer or line be allowed to touch the ground or come in contact with other physical objects that might introduce contaminants into the sample
- Immediately after sampling is completed, all equipment shall be decontaminated Siliceous tubing used with peristaltic pumps will be discarded

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5.5 DECONTAMINATION

Decontamination shall be performed before and after all sampling and data collection activities as described in SOPs FO.3, General Equipment Decontamination; SOP FO.6, Handling of Personal Protective Equipment, SOP FO 7, Handling of Decontamination Water and Wash Water; and SOP FO 9, Handling of Residual Core and Laboratory Samples.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP

The Quality Assurance Project Plan (QAPjP) outlines program-wide quality assurance objectives and identifies organization and responsibilities for attaining those objectives. The QAPjP also defines general QA methods to be implemented on projects. However, each project's Quality Assurance Addendum (QAA) defines project-specific organization and responsibilities, and specific methods and frequencies that will apply to a given project, such as QA audits and QA samples.

QA samples fall into five categories:

- Duplicate
- Matrix spike
- Matrix spike duplicate
- Equipment rinsate
- Lab replicate

SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples describes the general handling of samples. Applicable project plans specify QA sample functions.

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6.1 **DUPLICATES, MATRIX SPIKES, MATRIX SPIKE DUPLICATES AND LAB REPLICATES**

Sample collection procedures for QA samples, will be the same as those described in Subsection 5.4.2 Water Sampling Procedures. Duplicates are obtained immediately after the suite of analytes that they are intended to duplicate have been collected.

6.2 **EQUIPMENT RINSATES**

A rinsate sample from sampling equipment is intended to check for potential contamination of the sample by the sampling equipment. The rinsate will be taken after decontamination and prior to the sampling event.

The rinsate samples will be analyzed for the same parameters as the surface water samples.

The rinsate will be taken using the same equipment to be used in the sampling event. Except for VOCs, the peristaltic pump and tubing shall be used to pump out of a container of distilled water into an identical set of sample containers as to be used for the actual sampling event. A new disposable filter will be used as part of the tubing assembly when collecting rinsates for dissolved constituents. For VOCs, fill the discrete sample bottle, from the discrete sampler equipment, with distilled water and pour into the VOC bottles using the same procedure for collecting VOCs as given in SOP SW.3, Surface Water Sampling.

7.0 **DOCUMENTATION**

The Pond Water Data Collection Form (SW.8A) that follows will be used for documentation of pond sampling activities.

POND WATER DATA COLLECTION FIELD NOTES

SAMPLE ID _____ SITE ID _____ LOCATION _____

COLLECTION DATE _____ QUARTER 1 2 3 4 DRY Y / N

COLLECTION TIME _____ PURPOSE _____

SAMPLE TYPE: Grab Composite Depth-Integrated EWI-Composite Other _____

COMPOSITE DESCRIPTION _____

QC TYPE: REAL MS MSD LR DUP RNS QC PARTNER _____

SAMPLES COLLECTED BY IMMERSION _____

SAMPLES COLLECTED BY PUMP _____

SAMPLER TYPE Geopump Beaker/Dipper Discreet Zone Bottle Sampler Other _____

TEAM LEADER _____ TECH _____ TECH _____ TECH _____

VOLUME COLLECTED _____ UNITS _____

COMMENTS DISSOLVED METALS AND RADS FILTERED OTHER _____

Sampled from

Shore Waded Boat Bridge Other _____

Sampler Composition

Teflon Glass Stainless Steel Polyethylene Silicon Other _____

Sampling Conditions

Ice Coverage % _____ Other _____

Weather:

Clear Calm Hot Sunny P/C Lt Breeze Warm Fog Cloudy Windy Cool Rain
Gusty Cold Sleet V Cold Snow Other _____

SITE VISITOR _____ POSITION _____

SITE VISITOR _____ POSITION _____

SITE VISITOR _____ POSITION _____

Sampler _____ Parameters (HydroLab) (Hach)

FIELD CALIBRATION								
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
ph			UNITS					
SC			mS/CM					
DO			MG/L					

Prepared by _____ Signature _____

DEPTH _____ POND WATER DATA COLLECTION FIELD NOTES								
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
T air			°C		—	—		
T H ₂ O			°C		—	—		
DO			MG/L		—			
pH			UNITS		—			
CL ₂			MG/L	—	DPD	—		
ALKA			MG/L		1.6/ 16 N H ₂ SO ₄ /50ml 100ml	DIGITAL COUNTS 8.3 4.5		
SC			ms/CM					
SILICA								

DEPTH _____ FIELD MEASUREMENTS								
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
T air			°C		—	—		
T H ₂ O			°C		—	—		
DO			MG/L		—			
pH			UNITS		—			
CL ₂			MG/L	—	DPD	—		
ALKA			MG/L		1.6/ 16 N H ₂ SO ₄ /50ml 100ml	DIGITAL COUNTS 8.3 4.5		
SC			ms/CM					
SILICA								

DEPTH _____ FIELD MEASUREMENTS								
PARAMETER	METER ID	VALUE	UNIT	TEMP °C	STANDARD	RANGE SET	TIME	INITIALS
T air			°C		—	—		
T H ₂ O			°C		—	—		
DO			MG/L		—			
pH			UNITS		—			
CL ₂			MG/L	—	DPD	—		
ALKA			MG/L		1.6/ 16 N H ₂ SO ₄ /50ml 100ml	DIGITAL COUNTS 8.3 4.5		
SC			ms/CM					
SILICA								

Site ID _____ Date _____ Signature _____

This is a
CONTROLLED DOCUMENT
EG&G - ROCKY FLATS PLANT
ENVIRONMENTAL MANAGEMENT

This is a RED Stamp

INDUSTRIAL EFFLUENT DISCHARGE SAMPLING

EG&G ROCKY FLATS PLANT
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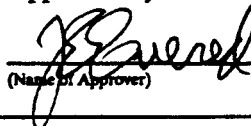
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Approved By:

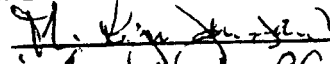

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REVIEWED FOR CLASSIFICATION/UCNI

By 
Date March 9, 1992

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2.0 PURPOSE AND SCOPE

This SOP describes procedures that will be used at the Rocky Flats Plant. It addresses the current National Pollutant Discharge Elimination System (NPDES) industrial effluent discharges but is applicable to all industrial effluent discharges for the Rocky Flats Plant. The purpose of this procedure is to ensure that the collection of representative samples meet applicable regulations, appropriate sampling protocols, and acceptable field measurement methods so that acceptable standards of accuracy, precision, comparability, representativeness and completeness will be attained.

Under the authority of the NPDES established by section 402 of the Clean Water Act (CWA) (33 U.S.C. 1251, et seq.), the U.S. EPA and the State of Colorado have promulgated regulations for monitoring liquid effluent discharges. By these authorities the RFP has been issued a permit to discharge to the receiving water of South Walnut Creek, North Walnut Creek, and Woman Creek with control on the conditions and limits under which discharge may take place. Permit No. CO-0001333, issued in November 1984, is in the process of revision due to an NPDES Federal Facilities Compliance Agreement (FCAA) entered into pursuant to Executive Order 12088, 43 Federal Regulation 47707 (1978). In addition, the Department of Energy (DOE) Order 5400.1, DOE Environmental Safety and Health Directive (11/09/88), specifies that compliance with NPDES requirements is mandatory for DOE operations. The Order also states DOE policy "to conduct its operations in an environmentally safe and sound manner" and requires monitoring of effluent discharges and ambient water quality.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing these procedures are required to have the appropriate health and safety training as specified in the site-specific Health and Safety Plan. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

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Only qualified personnel will be allowed to perform these procedures. Required qualifications vary depending on the activity to be performed. In general, qualifications are based on education, previous experience, on-the-job training, and supervision by qualified personnel

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure

MCD-51. NPDES Compliance Inspection Manual U S Environmental Protection Agency
May 1988

Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms 3rd Edition USEPA/6000/4/85/013 March 1985

Region VIII USEPA NPDES Acute Test Conditions-Static Renewal Whole Effluent Toxicity

Code of Federal Regulations 40 CFR parts 122, 123, 125, 133, and 136

Methods for Chemical Analysis of Water and Waste. U S Environmental Protection Agency 1979

DOE Order 5400.1 U S Department of Energy Environmental Safety and Health Directive November 1988

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4.2 INTERNAL REFERENCES

Rocky Flats Plant NPDES Permit No. CO-0001333

Rocky Flats Plant NPDES Federal Facilities Compliance Agreement

Related SOPs cross-referenced by this SOP are as follows

- SOP FO 3, General Equipment Decontamination
- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil And Water Samples
- SOP FO 14, Field Data Management
- SOP SW 2, Field Measurements of Surface Water Field Parameters
- SOP SW.3, Surface Water Sampling
- SOP SW 15, River and Ditch Sampling

5.0 METHODS

5.1 SAMPLE COLLECTION AND PRESERVATION

Collection of representative effluent samples requires that a reliable procedure be developed and implemented. Since each effluent location may have conditions or requirements that make it unique, each location must be evaluated on a site-by-site basis. This SOP addresses criteria for effluent sampling, including sampling necessary to meet the requirements of NPDES Permit No. CO-0001333, as modified by the 1990 NPDES FFCA. Surface Water samples will be collected following SOP SW.3, Surface Water Sampling. Composite samples will be collected with an automatic sampler following manufacturer's

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instructions for its operation. Sampling sites will be located at the points specified in the field sampling plan and the NPDES permit. Parameters measured in the field will comply with SOP SW.2, Field Measurements of Surface Water Field Parameters.

5.2 SAMPLE CUSTODY, PRESERVATION AND HANDLING

Sample containers used for sampling will be prepared and handled as described in SOP FO 13, Containerizing, Preserving, Handling and Shipping of Soil and Water Samples. Precleaned sample containers will be purchased by EG&G from a commercial laboratory supplier. If not purchased precleaned, the containers will be sanitized according to Contract Laboratory Program (CLP) procedures. Table 1 lists containers, preservatives, and holding times for NPDES samples. These requirements are based on 40 CFR 136 and regulations governing the collection of NPDES samples, which will take precedence over any conflicting information given in other guidance or SOP when collecting NPDES samples. Refer to NPDES/FFCA Operations Sampling Plan for a list of NPDES parameters.

5.3 GRAB AND COMPOSITE SAMPLING

Samples will be collected as either grab or composite samples, as specified by the NPDES permit, and/or the NPDES FFCA. Refer to the NPDES/FFCA Operations Sampling Plan for a list of composite sampling sites.

Surface water grab samples will be collected as required by SOP SW.3, Surface Water Sampling with attention given to certain parameters, such as oil and grease, which must be collected by sample container immersion, while others may be collected by the "dip and transfer" method. Volatile organics and fecal coliform will be collected by sample container immersion whenever possible. Discrete grab samples will be collected upstream of the point where the sample technician is standing.

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To comply with the permit, flow proportional composites will be collected as required. The composites will be collected as described in SOP SW 15, River and Ditch Sampling. It is anticipated that some revisions to this SOP or the field sampling plan will be required when a renewal NPDES permit is issued.

A major effort is underway at the RFP to install Parschall flumes and other structures to enable more accurate flow measurements at industrial effluent points, pond discharge locations, and on streams within the RFP boundary. This will also facilitate the collection of representative samples through the use of the automatic flow-proportional composite samplers.

When completed, most samples will be collected by automatic samplers. Until installation of the upgraded network is complete, some locations will require manual compositing of samples proportional to flow.

Manually composited individual grab samples will be thoroughly mixed prior to removing an aliquot to ensure that a representative sample is transferred to a container for analysis. Sample manipulation will be minimized to reduce the possibility of contamination.

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TABLE SW.9-1
CONTAINERS, SAMPLE PRESERVATION AND SAMPLE HOLDING TIMES

Parameter	Container	Preservatives	Holding Time (Hrs or Days)
HSL-VOAs	2x40mL vials with teflon	Cool 4°C ^(a) or	7 days
	lined septum lids	with HCl to pH < 2	14 days
Total Organic Carbon (TOC)	125mL - glass bottle	H ₂ SO ₄ to pH < 2	28 days
Biochemical Oxygen Demand ₅ (BOD ₅)	1L-glass ^(b)	Cool 4°C	48 hours
Biochemical Oxygen Demand Carbonaceous ⁵ (CBOD ₅)	1L-glass ^(b)	Cool 4°C	48 hours
Fecal Coliform	500mL-glass or poly (sterile)	Cool 4°C ^(a)	6 hours

- Add 0.008% Sodium thiosulfate (Na₂S₂O₃) in the presence of residual chlorine
- Poly bottles may be substituted if glass are not available
- Glass bottles may be substituted if polyethylene bottles are not available
- Holding Time for mercury is 28 days
- Amount is for Ceriodaphnia and Pimephales promelas test

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TABLE SW.9-1 (continued)
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Parameter	Container	Preservatives	Holding Time (Hrs or Days)
Oil and Grease	2x1-L-widemouth glass with teflon liner	Cool 4°C, H ₂ SO ₄ to pH < 2	28 days
Solids-Total	500mL-Poly ^(c)	Cool 4°C	7 days
Nitrate/Nitrite (as N)	500mL-Poly	Cool 4°C, H ₂ SO ₄ to pH < 2	28 days
HSL Metals-Total	1L-Poly	HNO ₃ to pH < 2	6 months ^(d)
Chromium-total	1L-Poly	HNO ₃ to pH < 2	6 months

- ^a Add 0.008% Sodium thiosulfate (Na₂S₂O₃) in the presence of residual chlorine
- ^b Poly bottles may be substituted if glass are not available
- ^c Glass bottles may be substituted if polyethylene bottles are not available
- ^d Holding Time for mercury is 28 days
- ^e Amount is for Ceriodaphnia and Pimephales promelas test

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TABLE SW.9-1 (continued)
CONTAINERS, SAMPLE PRESERVATION AND SAMPLE HOLDING TIMES

<u>Parameter</u>	<u>Container</u>	<u>Preservatives</u>	<u>Holding Time (Hrs or Days)</u>
Phosphorus-Total	250mL-glass	Cool 4°C, H ₂ SO ₄ to pH < 2	28 days
Static Bioassay	1 gallon Poly ^(e)	Cool 4°C	48 hours
pH, temperature, Total Residual Chlorine	In-situ, poly, glass or metal container	None	Analyze immediately

- ^a Add 0.008% Sodium thiosulfate (Na₂S₂O₃) in the presence of residual chlorine
- ^b Poly bottles may be substituted if glass are not available
- ^c Glass bottles may be substituted if polyethylene bottles are not available
- ^d Holding Time for mercury is 28 days
- ^e Amount is for Ceriodaphnia and Pimephales promelas test

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5.4 STATIC BIOASSAY

Whole effluent toxicity monitoring will be conducted at several effluent locations as required by the NPDES FFCA. Acute replacement static toxicity tests will be conducted in conformity with "Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms", USEPA 600/4-85/013 (revised March 1985) and the Region VIII USEPA "NPDES Acute Test Conditions - Static Renewal Whole Effluent Toxicity" USEPA Region VIII procedures will take precedence in case of any conflicts

Acute 48-hour replacement static tests using Ceriodaphnia and acute 96-hour replacement static tests using Pimephales promelas will be conducted from a 2-gallon flow-proportioned composite sample collected for this analysis Pimephales promelas used in the test will be $5 \pm$ days of age

6.0 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Quality Assurance (QA) and Quality Control (QC) will be accomplished according to applicable project plans as well as quality requirements presented in this SOP. Additional QA/QC requirements may be added if it is determined they are needed to ensure the quality of the data.

The most common monitoring errors are typically the result of improper sampling, improper preservation, and exceeding sample holding times. Errors of this type will be minimized by the use of this SOP which addresses all of these issues and through the training provided for the technicians.

The three types of QC samples to be collected are

- Duplicate
- Rinsate samples
- Split samples

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6.1 FIELD DUPLICATE SAMPLES

Field duplicate samples are independent samples collected from the same source, so they are, to the extent possible, equally representative of the parameter(s) of interest at a given point in time

6.2 EQUIPMENT RINSATE SAMPLES

Equipment rinsate samples are samples that are obtained by pouring analyte-free distilled water through decontaminated sample collection equipment (dipper, compositing container, pump, etc) and collecting the rinsate in the appropriate container for chemical analysis. These samples are used to determine the effectiveness of the decontamination procedures.

6.3 SPLIT SAMPLES

Split samples involve collecting a single sample and dividing the sample into two containers for analysis by separate laboratories. While infrequently employed, split samples are beneficial in identifying problems and discrepancies within the analytical laboratories.

6.4 QA/QC SAMPLE FREQUENCIES

Matrix spike and matrix spike duplicate analyses are run as internal lab checks and frequencies will be determined by analytical laboratory procedures. Equipment rinsates and sample duplicates will be collected at a minimum frequency of one per 20 field samples. Split samples should be collected at a frequency of one per 100 samples or at least once each year. Refer to the NPDES/FFCA Operations Sampling Plan for specific QA/QC requirements.

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6.5 FIELD INSTRUMENT CALIBRATION

Field instruments will be calibrated in accordance with SOP SW.2, Field Measurement of Surface Water Field Parameters

7.0 DOCUMENTATION

Proper chain of custody and documentation will be maintained at all times by following SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. A permanent record of the implementation of this SOP will be kept by documenting field observations and data. Observations and data will be recorded on daily NPDES logsheets that identify the required data entries or in a bound field notebook with consecutively numbered pages. Field logbooks will generally be utilized to summarize the daily field activities and to document project information not required by the field forms.

Permanent ink will be used for all entries in the logbooks and on the field forms. Mistakes will be crossed out with a single line, initialed, and dated. Unused pages or partial pages will be voided by drawing a line through the blank sections and initialing. Any deviation from this SOP requires documentation in the site supervisor's logbook.

The field activity daily log narrative should create a chronological record of the media team's activities, including the time and location of each activity. Any descriptions of problems encountered, personnel contacted, deviations from the SOP, and visitors on site should also be included. The weather conditions, date, signature of the person responsible for entries, and the number of field activity daily log sheets used to record media team activities for a given day will also be included.

Sample identification and data handling will conform to SOP FO 14, Field Data Management.

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REVIEWED FOR CLASSIFICATION/UCNI

By J. J. Jones
Date 7/10/1992

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2.0 PURPOSE AND SCOPE

This SOP describes procedures that will be used at the Rocky Flats Plant (RFP). It addresses the current EPA and State of Colorado Primary Drinking Water Regulations concerning the collection of bacteriological water samples but is applicable to all bacteriological water sampling for the RFP. The purpose of this procedure is to ensure that the collection of representative bacteriological samples meets applicable regulations and appropriate sampling protocols as specified in the Colorado Primary Drinking Water Regulations, Colorado Department of Health, Water Quality Control Division, Drinking Water Section, April 30, 1991.

The Code of Federal Regulations (CFR), Part 141.1, defines a public water system as "a system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year." Public water systems are classified as either community or non-community water systems. A community water system is defined as "a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents." A non-community water system is defined as "a public water system that is not a community system."

Under the authority of the Colorado Department of Health (CDH), Colorado Primary Drinking Water Regulations, public water systems must collect total coliform samples at regular intervals throughout the month from sites that are representative of the water throughout the distribution system. Community water systems must monitor for total coliform at a frequency based on the population served by the system, as specified in the CDH, Colorado Primary Drinking Water Regulations. Non-community water systems utilizing surface water must monitor at the same frequency as like-sized community water systems. The RFP qualifies as a non-transient, non-community public water system that utilizes surface water and must, therefore, meet the requirements of the Colorado Primary Drinking Water Regulations pertaining to this type of system.

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3 0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing these procedures are required to have the appropriate health and safety training as specified in the site-specific Health and Safety Plan. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and receive specific training regarding these procedures, if necessary.

Personnel performing bacteriological sampling will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

4 0 REFERENCES

4 1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

MCD-51. NPDES Compliance Inspection Manual. USEPA, May 1988

Code of Federal Regulations. 40 CFR parts 141 and 142 .

Methods for Chemical Analysis of Water and Waste. USEPA 1979

Colorado Primary Drinking Water Regulations. Colorado Department of Health, Water Quality Control Division, Drinking Water Section, April 30, 1991

DOE Order 5400.1 General Environmental Protection Program, November 8, 1988

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Microbiological Methods for Monitoring the Environment. Water and Wastes Environmental
Monitoring and Support Laboratory, Cincinnati EPA-600/8-78-017-December, 1978

Standard Methods for the Examination of Water and Waste Water APHA-AWWA-WPOF-17th
Edition, 1989

Manual for the Certification of Laboratories Analyzing Drinking Water, 3rd Edition The
Laboratory Certification Program Revision Committee EPA/570/9-90/008-April 1990

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows

- SOP FO.3, General Equipment Decontamination
- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
- SOP FO 14, Field Data Management
- SOP SW 2, Field Measurements of Surface Water Field Parameters
- SOP SW.3, Surface Water Sampling

5.0 METHODS

Colorado Primary Drinking Water Regulations require non-community water systems using surface water to monitor at the same frequency as like-sized community water systems Based on the current RFP population served, a minimum of nine samples per month will be collected

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5.1 ROUTINE SAMPLE COLLECTION AND PRESERVATION

Collection of representative bacteriological samples from the water system requires that a reliable procedure be developed and implemented. Sampling sites and frequencies will be as specified in the Field Sampling Plan. Samples will be collected and preserved as follows:

- Samples will be collected as specified in SOP SW 7, Collection of Tap Water Samples
- Samples will be collected at the frequency specified in the Field Sampling Plan which at a minimum will comply with the requirements of Section 3.1, paragraph (1) (e) (iv) of the Colorado Primary Drinking Water Regulations
- Samples will be collected in pre-sterilized plastic or glass containers, preserved with sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) to 0.008 percent and cooled to 4°C, except that the $\text{Na}_2\text{S}_2\text{O}_3$ is not required when chlorine is not present. All sample bottles will be filled to 1-2 inches below the top. This will allow head space for mixing at the analytical lab.
- The Standard Sample size will be 100 ml

5.2 REPEAT SAMPLING AFTER DETECTION OF COLIFORM BACTERIA

When a routine sample is total coliform positive, additional bacteriological samples will be collected as follows:

- (1) Samples will be collected within 24 hours after notification of the positive results

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- (2) Samples will be collected from the original total coliform-positive tap sample location, one sample from five service connections upstream, and one sample from five service connections downstream of the original total coliform-positive site. If the tap sample location is less than five service connections from the beginning or end of the distribution system, then available service connections from the coliform-positive location to the beginning or end of the distribution system will be sampled.
- (3) When the total coliform positive sample site is less than two service connections from the end of the distribution system, the RFP Industrial Hygiene Department (telephone number 966-4229) will be contacted for guidance concerning appropriate sampling locations. The Industrial Hygiene Department will contact CDH for guidance in selection of the proper sampling locations.
- (4) If one or more repeat samples in the set are positive for coliform, an additional set of repeat samples will be collected as specified in items 1 through 3 above. This process will be repeated until coliforms are not detected in one complete set of sample. If it is determined that the maximum contaminant level (MCL) for total coliforms (see Subsection 5.6) has been exceeded, then CDH will be notified of the noncompliance. The RFP Industrial Hygiene Department will also be contacted for guidance in identifying the source of the problem and correcting the problem.
- (5) If it is determined that the maximum contaminant level has been exceeded, monitoring will be continued as specified in items 2 and 3, at a minimum frequency of once per week for the remainder of the month or until total coliforms are not detected in two consecutive samples taken at the original sampling site.

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5.3 FECAL COLIFORM AND ESCHERICHIA (E. COLI) TESTING

If any routine or repeat sample is positive for total coliform, the total coliform-positive culture medium will be analyzed for fecal coliforms or E. coli to determine if they are present. If either fecal coliforms or E. coli are present, the CDH will be notified by the end of the day after receipt of the test results, unless results are received after the CDH is closed for the day, in which case the CDH will be notified before the end of the next business day.

5.4 SAMPLE ANALYSIS

All samples will be analyzed by a laboratory certified by the CDH to perform drinking water analyses. Samples will be analyzed by one of the methods specified in 40 CFR, Part 141.21(f)(1) - (6).

At the present time the RFP on-site lab (123) is in the process of state certification. Off-site labs will be used until 123 lab is certified.

5.5 INVALIDATION OF TOTAL COLIFORM SAMPLE RESULTS

Samples in which total coliform are not detected will be invalidated by the laboratory if any of the following conditions occur:

- (1) The sample produces a turbid culture in the absence of gas production using an analytical method where gas formation is examined (e.g., the Multiple-Tube Fermentation Technique), or
- (2) The sample produces a turbid culture in the absence of an acid reaction in the Presence-Absence (P-A) Coliform Test, or

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- (3) The sample exhibits confluent growth or produces colonies too numerous to count with an analytical method using a membrane filter (e g , Membrane Filter Technique)
- (4) If a laboratory invalidates a sample, another sample will be collected from the same location as the original sample within 24 hours of being notified of the interference problem, and the sample will be analyzed for the presence of total coliform Re-sampling within 24 hours of the notification of interference problems will continue and the samples analyzed until a valid result is obtained If logistical reasons prevent re-sampling within the 24-hour time limit, the CDH will be contacted to request that this requirement be waived, and a new time limit established by the CDH for re-sampling

The CDH may also invalidate total coliform sample results if the following conditions are met

- (1) The laboratory establishes that improper sample analysis caused the total coliform-positive result
- (2) On the basis of the results of repeat samples collected, the CDH determines that the total coliform-positive sample resulted from a domestic or other non-distribution system plumbing problem as shown by repeat samples from the original tap continuing to show coliform bacteria, while the other repeat samples are coliform negative

Total coliform sample results invalidated under this subsection will not count towards meeting the minimum monitoring requirements

5 6 REPORTING AND COMPLIANCE

Maximum contaminant levels (MCLs) are based on the presence or absence of total coliform in a sample, and not on coliform density When fewer than 40 routine samples per month are collected,

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the system is in compliance with the MCL for total coliform if no more than one sample collected during a month is total coliform positive. When a system collects 40 or more samples in a month, the system is in compliance with the MCL for total coliforms if no more than 5.0 percent of the samples collected during the month are total coliform positive.

Any fecal coliform-positive repeat sample or E. coli-positive repeat sample, or any total coliform-positive repeat sample following a fecal coliform-positive or E. coli-positive sample constitutes a violation of the MCL for total coliform. This is a violation that may pose an acute risk to health.

Compliance with the MCL for total coliforms will be determined for each compliance period in which monitoring for total coliform is required. Results of all routine and repeat total coliform samples will be submitted to the CDH for review. Results of both routine and repeat samples will be utilized for compliance determination, except for results that have been invalidated according to the procedures specified in Subsection 5.5. Special purpose samples, such as those taken to determine whether disinfection practices are sufficient following pipe installation or repair, will not be used to determine compliance with the MCL for total coliform.

If the MCL for total coliform is exceeded, the violation will be reported to the CDH Water Quality Control Division no later than the end of the next business day after learning of the violation. Written notification of the violation will be given to CDH within 10 days after learning of the violation. The public will be notified in accordance with Article 12 of the Colorado Primary Drinking Water Regulations.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) activities will be accomplished according to applicable project plans as well as quality requirements presented in this SOP.

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The Quality Assurance Project Plan (QAPjP) outlines program-wide quality assurance objectives and identifies organization and responsibilities for attaining those objectives. The QAPjP also defines general QA methods to be implemented on projects. However, each project's Quality Assurance Addendum (QAA) defines project-specific organization and responsibilities, and specific methods and frequencies that will apply to a given project, such as QA audits and QA samples.

QA samples for Bacteriological sampling fall into two categories:

- Duplicate
- TFC field readings

SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples, describes the general handling of samples. The field sampling plan specifies QA sample functions.

Sample collection procedures will be the same as those described in Subsection 5.5 for duplicate samples. Duplicates are obtained immediately after the collection of the original sample that they are intended to duplicate. Since bacteriological samples are collected directly into the sample containers, no sampling equipment is utilized and, therefore, equipment rinsates are not collected.

When sampling for bacteria within predetermined locations along the plant water distribution system, QA/QC checks can be performed by collecting and determining Total Free Chlorine (TFC) values in the field. At any point within the system the TFC should range from 1.0 mg/L to 0.5 mg/L. If the TFC is lower than 0.5 mg/L this may indicate (1) inadequate chlorine distribution from the Water Treatment Plant (WTP), or (2) inadequate purging before the sample is collected. If the TFC reading is below 0.5 mg/L the samplers will repurge the system and take another TFC reading. With a confirmation of low TFC the samplers will contact the EG&G contact.

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7.0 DOCUMENTATION

Proper chain of custody and documentation will be maintained at all times by following SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. A permanent record of the implementation of this SOP will be kept by documenting field observations and data. Observations and data will be recorded on pre-approved field forms that identify the required data entries or in a bound field notebook with consecutively numbered pages. Field logbooks will generally be utilized to summarize the daily field activities and to document project information not required by the field forms.

Permanent ink will be used for all entries in the logbooks and on the field forms. Mistakes will be crossed out with a single line, initialed, and dated. Unused pages or partial pages will be voided by drawing a line through the blank sections and initialing. Any deviation from this SOP requires documentation in the site supervisor's logbook.

The field activity daily log narrative should create a chronological record of the media team's activities, including the time and location of each activity. Any descriptions of problems encountered, personnel contacted, deviations from the SOP, and visitors on site should also be included. The weather conditions, date, signature of the person responsible for entries, and the number of field activity daily log sheets used to record media team activities for a given day will also be included. Sample identification and data handling will conform to SOP FO 14, Data Base Management.

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(Name of Approver)

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(Date)

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By

Date

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2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures to be used in the collection of water samples from rivers, streams, and ditches located offsite from the Rocky Flats Plant (RFP) or at the RFP in support of National Pollutant Discharge Elimination System (NPDES) permit compliance at the RFP. This procedure sets forth methods for collection of samples at any specific site based upon physical characteristics and dimensions of the water body

This SOP addresses the collection of representative ambient water quality samples that meet applicable regulations and appropriate sampling protocols. Applicable Federal and Department of Energy (DOE) regulations include

- Rocky Flats Plant NPDES Permit Number CO-0001333
- 40 CFR Parts 122, 123, 125, 133, and 136
- DOE Order 5400.1
- RFP NPDES Federal Facilities Compliance Agreement

Sampling locations, sampling frequencies, and a list of analytes to be collected will be specified in the project field sampling plan.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

Personnel performing river and ditch sampling will be geologists, hydrologists, engineers, or field technicians with an appropriate amount of applicable field experience or on-the-job training under supervision of another qualified person.

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4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

MCD-51 NPDES Compliance Inspection Manual U S Environmental Protection Agency May 1988

Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms 3rd Edition EPA/6000/4/85/013 March 1985

Region VIII EPA NPDES Acute Test Conditions-Static Renewal Whole Effluent Toxicity.

Code of Federal Regulations 40 CFR 136

Methods for Chemical Analysis of Water and Waste U S. Environmental Protection Agency 1979

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows.

- SOP FO.3, General Equipment Decontamination
- SOP FO 7, Handling of Decontamination Water & Wash Water
- SOP FO 10, Receiving, Labeling, and Handling Environmental Materials Containers
- SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples

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- SOP SW.2, Field Measurement of Surface Water Field Parameters
- SOP SW.3, Surface Water Sampling

5.0 METHODS

Samples will be collected as either grab or composite samples. Grab sampling techniques include sample container immersion, "dip and transfer," and depth-integrated sampling. Samples for certain analytes are to be collected only by sample container immersion, while others may be collected by container immersion or the "dip and transfer" method. Depth-integrated (vertical areal composite) sampling is described in Subsection 5.3.1. Grab sampling methods are described in SOP SW.3, Surface Water Sampling.

The Equal Width Increment (EWI) method will be used to collect composite samples. This method, performed by wading in streams or by remote sampling, is described in Subsection 5.3.2.

The number of sampling points at each location will vary with the width and depth of the water body. In narrow streams, collection of a single depth-integrated sample at the deepest point may be sufficient. In wider streams or rivers, several subsamples (aliquots) will be combined to form a single composite sample, which is then divided into discrete samples. Refer to Subsection 5.2, Criteria for the Selection of Sampling Methods and Equipment, for details.

5.1 FIELD SAMPLING EQUIPMENT

Equipment used for collecting and compositing surface water samples from rivers and streams may include but is not limited to the following:

- DH-48 depth-integrated sampler
- DH-59 depth-integrated sampler

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- USGS Churn Splitter
- Laboratory Provided Sample Containers
- Sample Transfer Devices

5.1.1 DH-48 and DH-59 Depth-Integrated Samplers

The DH-48 depth-integrated sampler, which will be used to collect samples when wading a stream or river, consists of a streamlined aluminum casting, 13 inches long, which partly encloses a sample container. The sampler, including the quart-size sample bottle, weighs 4.5 pounds. A standard stream-gauging wading rod is threaded into the top of the sampler body for suspending the sampler. Samples are collected through an intake nozzle and discharged into the bottle. The sampler can be used to collect water samples, except for those which must be collected as grab samples.

Although the sampler casting is made of aluminum, it will be acceptable for sampling because sample water will not come in contact with the aluminum. The intake nozzle should be made of inert material so no contamination of the sample takes place. Modification of the nozzle may be required to ensure that it is of an inert material. If high levels of aluminum are found in samples collected with this device, the DH-48 sampler will be investigated as a potential source.

The DH-59 is similar to the DH-48 sampler with some differences in application. Instead of having a wading rod attached, the device is equipped with a cable so that it can be remotely operated from bridges.

5.1.2 USGS Churn Splitter

The churn splitter is a device which mixes sample aliquots to form a sample composite and then splits the composite into discrete samples. Samples may be taken from the churn splitter for analysis of all dissolved and suspended inorganic constituents with the exception of total organic carbon.

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(TOC), fecal coliform, volatile organic analyses (VOCs), and oil and grease (O&G) The churn bucket should not be used as a direct sampling device; rather, water is collected in a depth-integrating sampler and poured into the churn splitter. The churn splitter is then used to mix the composited liquid while splitting the total volume into the various analyte samples.

Samples collected by the EWI method, described in Subsection 5.3.2, are composited and split in either an 8-liter or a 14-liter churn splitter. A total of 10 liters of the sample mixture can be withdrawn from the 14-liter churn, the remaining 4 liters should not be used directly because they will not be representative. Similarly, 5 liters can be withdrawn from the 8-liter churn. The sample mixture remaining in either churn can, however, be used for filtered samples. Unfiltered water samples should be withdrawn first and then filtered samples may be taken from the churn bucket with a peristaltic pump.

5.1.3 Laboratory Provided Sample Containers

Whenever possible, laboratory-provided sample containers will be used to collect water quality samples. Alternatively, the containers may be purchased from a supplier who certifies that bottles have been pre-cleaned to EPA specifications. Records certifying pre-cleaning will be kept for these containers.

5.1.4 Sample Transfer Devices

Beakers or dippers, composed of Teflon®, stainless steel, or glass, may be used if site conditions prevent sampling by sample container immersion. Procedures for the use of transfer devices for sample collection are described in SOP SW.3, Surface Water Sampling. The type, composition, and volume of the transfer device will be recorded in field notes.

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5.2 CRITERIA FOR THE SELECTION OF SAMPLING METHODS AND EQUIPMENT

The selection of sampling methods and equipment is based on sample type, flow conditions, and data quality objectives stated in the field sampling plan.

Surface water samples that must be collected as grab samples and their sample collection methods are as follows

- VOCs will be collected by container immersion or dipper with transfer
- O&G will be collected by sample container immersion.

Selection of sampling methods and equipment based on flow conditions is as follows

- If depth is less than 10 ft, samples will be collected using methods described in SOP SW.3, Subsection 5.3.2.2, Samples Collected by Container Immersion or Subsection 5.3.5, Sampling Under Low Flow Conditions
- If depth is greater than 10 ft and the stream is less than 5 ft wide, use the vertical areal composite method described in Subsection 5.3.1 of this SOP
- If depth is greater than 10 ft and the stream is at least 5 ft wide, use methods described in Subsection 5.3.2, EWI Method of Sampling for Dissolved Chemical Constituents of this SOP The DH-48 sampler may be used for this method

If a bridge spanning the river is available for sampling purposes or the stream cannot be waded safely, the EWI method should be employed along with remote sampling techniques described in Subsection 5.3.4, Remote Sampling, of SOP SW.3, Surface Water Sampling. The DH-59 sampler should be used for this procedure

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5.3 PROCEDURES

Samples will be collected from the same cross-section of the stream as that used for the discharge measurement if discharge is measured. Always collect samples prior to making discharge measurements

The sample for total residual chlorine analysis will be collected prior to the collection of any other samples or measurement of any other parameters. Total residual chlorine will be measured, as described in SOP SW.2, Field Measurement of Surface Water Field Parameters, to determine if VOCs, cyanide, and Base Neutral Acid (BNA) samples require special preservatives. Refer to Subsection 5.4, Sample Containers, Preservation, and Handling.

5.3.1 Depth-Integrated Sampling

Depth-integrated grab samples (vertical areal composites) are collected for streams with depth greater than 1 ft and width less than 5 ft as follows

- Locate the approximate center of flow in the stream, and position yourself facing upstream at this location
- Lower open sample bottle to the bottom of the stream, taking care not to disturb bed materials, and raise it to the surface. The bottle should be lowered and raised at a uniform rate that allows the bottle to be completely filled as it reaches the surface
- Recap and decontaminate the sample bottle exterior.

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5.3.2 EWI Method of Sampling for Dissolved Chemical Constituents

The EWI method should be used where the width of the body of water to be sampled is greater than 5 ft and average depth is greater than 10 ft. The EWI method requires equal spacing of several sampling verticals across the cross-section and an equal transit rate (ETR), both up and down, in all verticals. The transit rate is the rate at which the DH-48 or similar sampler is lowered or raised along the water vertical. A proper transit rate is one that results in a full bottle when sampling at the vertical having the greatest unit width discharge. Verticals are the span between the water surface and the stream bottom at selected sampling points across the stream cross-section.

In the EWI method, the width of the stream is measured with an engineer's tape or with a tagline. A tagline is a measurement device for wide (greater than 25 ft) streams. Typically, a steel engineer's tape with 1-foot and 0.1-foot increments will suffice. The tape or tagline is suspended about 1 foot above, and across the stream perpendicular to the direction of flow, to permit measurement and division into sampling intervals.

Guidelines for the collection of water samples using the EWI method are as follows:

- Suspend a measuring tape or tagline across the stream, about 1 foot from the water surface, perpendicular to the direction of flow.
- Visually inspect the stream from bank to bank, observing the velocity and depth distribution as well as apparent distribution of sediment in the cross-section.
- Determine the number of intervals to be sampled, based on stream width, velocity, depth, and the volume of sample required. Three to 5 intervals should be sufficient for most streams. If the stream has fairly uniform velocity and depth, and

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the width is less than 25 feet, 3 intervals may be used. More intervals should be added for streams that are not uniform in velocity or depth.

- Assemble the DH-48 depth integrated sampler, and decontaminate the sampler according to SOP FO.3, General Equipment Decontamination.
- Locate the vertical containing the largest discharge. This is generally the vertical with the highest flow velocity, and is located near the center of the stream.
- Determine the transit rate for the maximum discharge vertical.
- Determine the width of the segment to be sampled (the distance between verticals) by dividing the stream width by the number of verticals selected.
- Record the bank closest to the first sampling station and the time at which sampling begins. Time is recorded to the nearest 5 minutes in military time.
- Move sampling and support equipment to the first station to be sampled. The sampling verticals will be located at the center of the cross-section intervals. For example, if the interval width is 10 feet, the first station will be 5 feet from the stream bank. The second station will be 15 feet from the bank.
- Collect samples for chemical constituents in one-quart bottles. More than one vertical may be sampled using the same bottle (in verticals of lower discharge) until the volume is about 3 inches from the top of the bottle. Do not add more than this because the sample will no longer be representative. If overfilling should occur, the bottle should be emptied, rinsed with a small volume of sample water, and the sample should be taken again. After collecting the sample, empty the

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bottle contents into the churn splitter. Replace the bottle in the sampler and continue sampling in the same manner until all of the verticals have been sampled.

- Individual samples for the determination of chemical constituents (except those for VOCs, and O&G) should be composited in the churn splitter
- Record the bank closest to the final sampling station and the time, to the nearest 5 minutes, at which sampling was completed
- Disassemble and decontaminate sampling equipment according to SOP FO.3, General Equipment Decontamination.

5.4 SAMPLE CONTAINERS, PRESERVATION, AND HANDLING

A list of containers, preservatives, and holding times for sample parameters is included in SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. These requirements are based on 40 CFR 136, and regulations governing the collection of NPDES samples, and will take precedence over any conflicting information given in other guidance or SOP when collecting off-site samples. Procedures discussed in SOP FO 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples will be followed for the handling and shipping of collected samples.

6.0 DECONTAMINATION

Procedures for decontamination are set forth in the site-specific health and safety plan and SOP FO.3, General Equipment Decontamination, SOP FO 7, Handling of Decontamination Water and Wash Water, and SOP FO 10, Receiving, Labeling, and Handling Environmental Materials Containers.

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7.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) will be accomplished according to SOP SW.3, Surface Water Sampling, Section 7.0, Quality Assurance/Quality Control. Additional QA/QC requirements may be added if it is determined they are needed to ensure the quality of the data

8.0 DOCUMENTATION

Information required by this SOP will be documented on the Surface Water Data Collection Field Notes form SW 1A, included in SOP SW 1, Surface Water Data Collection Activities or in field logbooks. Logbooks should include any information regarding sampling activities that is not required on form SW 1A, including; sampling times, deviation from procedures, or any other relevant information